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CONTENTS.

	Page.
INTRODUCTION	115
SECTION I.—AEROLOGY:	
Solar and sky radiation during March, 1918. H. H. Kimball	116
Promising chemical photometer for plant physiological research. C. S. Ridgway	117
Further study of halos in relation to weather. H. H. Martin	119
Remarkable halo observed at Nashville, Tenn. R. M. Williamson. (fig.)	120
Solar halo, March 16, 1918, at Banners Elk, N. C. T. L. Lowe. (fig.)	121
SECTION II.—GENERAL METEOROLOGY:	
Solar disturbances and terrestrial weather. E. Huntington. (8 figs.)	123
Breathing well in California. N. M. Cunningham	141
SECTION III.—FORECASTS:	
Forecasts and warnings for March, 1918. H. C. Frankenfield. (Charts II and III)	142
SECTION IV.—RIVERS AND FLOODS:	
Rivers and floods during March, 1918. A. J. Henry. (Chart I)	145
Great Lakes levels during February and March, 1918	146
SECTION V.—SEISMOLOGY:	
Seismological reports for March, 1918. W. J. Humphreys	147
Seismological dispatches for March, 1918	150
SECTION VI.—BIBLIOGRAPHY:	
Recent additions to the Weather Bureau Library. C. F. Talman	151
SECTION VI.—Bibliography—Continued.	
Recent papers bearing on meteorology and seismology. C. F. Talman	151
SECTION VII.—WEATHER AND DATA FOR THE MONTH:	
Weather of March, 1918. P. C. Day	152
Weather conditions over the North Atlantic during March, 1917 (with Chart IX)	153
Corrections to wind records at Portland, Me., and Baltimore, Md	155
Condensed climatological summary	156
Tables—	
Description	156
I. Climatological data for United States Weather Bureau stations	157
II. Accumulated amounts of precipitation	160
III. Data furnished by the Canadian meteorological service	162
Charts—	Charts.
I. Hydrographs, March, 1918	22
II. Tracks of centers of HIGHS	23
III. Tracks of centers of LOWS	24
IV. Departures of mean temperatures	25
V. Total precipitation for the month	26
VI. Percentage of clear sky	27
VII. Sea level isobars and isotherms, and prevailing winds	28
VIII. Total snowfall for the month	29
IX. Marine meteorological data for March, 1917	30

NOTICE TO CONTRIBUTORS.

Contributions intended for publication in any given issue of the MONTHLY WEATHER REVIEW (e. g., January) should be in the hands of the editor before the end of the next following month (e. g., February), if no illustrations are required. When the paper is illustrated, the manuscript and the copy for illustrations must be submitted much earlier, in order to permit copy being prepared for the engraver by the end of the month.

REPRINTS are made up without covers in the original size and pagination of the REVIEW. They will not be furnished unless specifically REQUESTED WHEN THE MANUSCRIPT IS SUBMITTED.

MONTHLY WEATHER REVIEW

HERBERT LYMAN, Acting Editor.

Vol. 46, No. 3.
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MARCH, 1918.

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INTRODUCTION.

As explained in this Introduction during 1914, the MONTHLY WEATHER REVIEW now takes the place of the Bulletin of the Mount Weather Observatory and of the voluminous publication of the climatological service of the Weather Bureau. The MONTHLY WEATHER REVIEW contains contributions from the research staff of the Weather Bureau and also special contributions of a general character in any branch of meteorology and climatology.

SUPPLEMENTS TO THE MONTHLY WEATHER REVIEW are published from time to time.

The climatological service of the Weather Bureau is maintained in all its essential features, but its publications, so far as they relate to purely local conditions, are incorporated in the monthly reports "Climatological Data" for the respective States, Territories, and colonies.

Beginning August, 1915, the material for the MONTHLY WEATHER REVIEW has been prepared and classified in accordance with the following sections:

SECTION 1.—*Aerology.*—Data and discussions relative to the free atmosphere.

SECTION 2.—*General meteorology.*—Special contributions by any competent student bearing on any branch of meteorology and climatology, theoretical or otherwise.

SECTION 3.—*Forecasts and general conditions of the atmosphere.*

SECTION 4.—*Rivers and floods.*

SECTION 5.—*Seismology.*—Results of observations by Weather Bureau observers and others as reported to the Washington office.

SECTION 6.—*Bibliography.*—Recent additions to the Weather Bureau library; recent papers bearing on meteorology.

SECTION 7.—*Weather of the month.*—Summary of local weather conditions; climatological data from regular Weather Bureau stations; tables of accumulated and excessive precipitation; data furnished by the Canadian Meteorological Service; monthly charts Nos. 1, 2, 3, 4, 5, 6, 7, 8, the same as hitherto; Meteorological Summary and chart No. 9 of the North Atlantic Ocean for this month in 1917. Owing to the fact that ocean meteorological data are frequently not available for a considerable time after the close of the month to which they relate, the chart and text matter in connection therewith appear one year late.

In general, appropriate officials prepare the seven sections above enumerated; but *all students of atmospherics are cordially invited to contribute such additional articles as seem to be of value.*

The voluminous tables of data and text relative to local climatological conditions, that during recent years were prepared by the 12 respective "district editors," are omitted from the MONTHLY WEATHER REVIEW, but are collected and published by States at selected section centers. (See cover, p. 3.)

The data needed in Section 7 can only be collected and prepared several weeks after the close of the month designated on the title-page; hence the REVIEW as a whole can only issue from the press within about eight weeks from the end of that month.

It is hoped that the meteorological data hitherto contributed by numerous independent services will continue as in the past. Our thanks are specially due to the directors and superintendents of the following:

The Meteorological Service of the Dominion of Canada.
The Meteorological Service of Cuba.
The Meteorological Observatory of Belén College, Habana.
The Government Meteorological Office of Jamaica.
The Meteorological Service of the Azores.
The Meteorological Office, London.
The Danish Meteorological Institute.
The Physical Central Observatory, Petrograd.
The Philippine Weather Bureau.

The Weather Bureau desires that the MONTHLY WEATHER REVIEW shall be a medium of publication for contributions within its field, but such publication is not to be construed as official approval of the views expressed.

CORRIGENDA.

The REVIEW, Feb. 1918:
Page 105, col. 1, 6th line from bottom, *for* "isotherm" *read* "isobar".
Page 108, Table 1, Pensacola, Fla., minimum temperature, *for* "4" *read* "37".
Do., date of min. temp., *for* "37" *read* "4".

SECTION I.—AEROLOGY.

SOLAR AND SKY RADIATION MEASUREMENTS DURING MARCH, 1918.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Washington, D. C., April 30, 1918.]

For a description of instrumental exposures, and an account of the methods of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, 1918, **46**: 2.

The monthly means and departures from normal values in Table 1 show that direct solar radiation intensities averaged slightly above normal at Madison, Wis., very close to normal at Lincoln, Nebr., and slightly below normal at Santa Fe, N. Mex., and Washington, D. C.

Table 3 shows an excess of radiation of a few per cent at all three stations, as compared with the normal radiation for the respective stations for March.

Skylight polarization measurements obtained at Washington on 11 days give a mean of 54 per cent with a maximum of 64 per cent on the 16th. These values are considerably below the average for Washington in March. Measurements obtained at Madison on five days after the 18th of the month give a mean of 66 per cent with a maximum of 71 per cent on the 22d.

On the 25th a peculiar and dense haze overspread the sky at Washington during the afternoon. At noon, with air mass 1.26 the radiation intensity was 1.37 calories. At 1 p. m. the sky polarization was 52 per cent. At 2 p. m., with air mass 1.60, the radiation intensity was 1.24 calories. The intensity then fell rapidly until 3 p. m., when it was only 0.54 calories with an air mass of 1.85. After that hour the haze diminished somewhat in density.

No cloud forms could be distinguished in this haze, but when first seen approaching the station from the west it had the appearance of a dense cloud bank on the horizon. There was more than the usual amount of haze in the atmosphere during the balance of the month.

TABLE 1.—*Solar radiation intensities during March, 1918.*

[Gram-calories per minute per square centimeter of normal surface.]

Washington, D. C.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Mar. 2	[1.41*]	1.32	1.24	1.18	1.10	1.02	0.95	0.89		0.77
4						0.78			0.67	
8		1.20	1.04	0.90	0.78	0.75	0.71	0.66	0.60	
11		1.28	1.19	1.11	0.92			0.75	0.72	0.64
16		1.36	1.22	1.10	0.98	0.88	0.79			
18		1.06	0.96	0.84	0.74	0.65	0.55			
23		1.40	1.32	1.25	1.18		0.91			
26				0.87	0.75	0.64		0.50	0.47	0.44
27		1.28	1.14				0.73	0.64	0.50	
28		0.79	0.65							
29	[1.40*]	1.31	1.22	1.10	1.03	0.96	0.90	0.84	0.79	0.74
Monthly means		**1.22**	**1.11**	**1.04**	**0.94**	**0 81**	**0.79**	**0.71**	**0.62**	**0.65**
Departure from 10-year normal		**−0.06**	**−0.04**	**−0.01**	**−0.01**	**−0.05**	**−0.01**	**−0.04**	**−0.09**	**−0.04**
P. M.										
Mar. 2			1.02	0.94	0.77					
7		1.26	0.98	0.74		0.51	0.47			
8		1.23	0.99	1.03	0.96	0.87	0.83	0.79		
16		1.38	1.24	1.16	1.06	1.00	0.93	0.87		
18		1.15	0.99	0.88	0.80	0.72	0.63	0.58	0.53	
25		1.26	0.53	0.49	0.43	0.42				
27		1.19	1.05	0.92	0.81	0.71	0.62	0.55		
29	[1.41*]	1.29	1.18	1.08	0.99	0.90	0.82	0.74		
Monthly Means		**1.25**	**1.00**	**0.90**	**0.83**	**0.73**	**0.72**	**0.71**	**(0.53)**	
Departure from 10-year normal		**−0.04**	**−0.13**	**−0.11**	**−0.09**	**−0.11**	**−0.07**	**−0.02**	**−0.14**	

* Extrapolated, and reduced to mean solar distance.

TABLE 1.—*Solar radiation intensities during March, 1918*—Continued.

Madison, Wis.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Mar. 1			1.38	1.27				0.97		
2			1.35	1.27	1.18	1.08	0.96			
15		1.58	1.41			1.26				
16			1.40	1.31	1.23	1.16				
19			1.31							
22			1.47	1.35						
27			1.37	1.25	1.15					
28		1.42	1.24							
Monthly means		**(1.50)**	**1.37**	**1.29**	**1.19**	**1.17**	**(0.96)**	**(0.97)**		
Departures from 8-year normal		**+0.06**	**+0.03**	**+0.01**	**−0.02**	**+0.03**	**−0.10**	**−0.09**		
P. M.										
Mar. 1		1.54	1.40							
2			1.41	1.36	1.30	1.24				
7			1.31	1.18						
15		1.56	1.36	1.31	1.27	1.11				
16		1.53	1.42		1.27	1.18	1.10	1.03		
26		1.38	1.31	1.14	0.99					
28		1.43								
Monthly means		**1.49**	**1.37**	**1.25**	**1.21**	**1.18**	**(1.10)**	**(1.03)**		
Departures from 8-year normal		**+0.06**	**+0.01**	**−0.02**	**±0.00**	**−0.03**	**±0.00**	**−0.05**		

Lincoln, Nebr.

Date.	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.										
Mar. 1		1.48	1.41	1.26	1.17	1.15	1.11			
7			1.30	1.20	0.95	0.92	0.89	0.86	0.75	
16		1.44	1.32	1.25	1.18	1.12				
19		1.47	1.34	1.26	1.19	1.13	1.05	0.97		
25		1.21	1.08	0.99	0.87	0.75				
27		1.10	1.00	0.84	0.75	0.67				
Monthly means		**1.34**	**1.24**	**1.13**	**1.02**	**0.96**	**1.02**	**(0.92)**	**(0.75)**	
Departure from 3-year normal		**+0.01**	**−0.01**	**+0.01**	**±0.00**	**+0.04**	**+0.09**	**−0.03**		
P. M.										
Mar. 1			1.33							
16	[1.48*]	1.38	1.31	1.24	1.18	1.12	1.07		0.93	0.91
19		1.39								
21		1.04								
24		1.24	1.13	0.98	0.91	0.84	0.77		0.71	0.66
25		1.17	1.07	0.99	0.92	0.84	0.75	0.68	0.62	
Monthly means		**1.24**	**1.21**	**1.07**	**1.00**	**0.93**	**0.86**	**(0.68)**	**0.75**	**(0.78)**
Departure from 3-year normal		**−0.02**	**+0.02**	**−0.03**	**−0.03**	**−0.03**	**−0.02**	**−0.13**	**−0.06**	

Santa Fe, N. Mex.

Date.	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.										
Mar. 1				1.23						
4	[1.56*]	1.51	1.44	1.38						
9		1.53	1.48	1.42	1.34					
14				1.37						
16		1.41								
18		1.51	1.42	1.33						
22		1.43								
23		1.45	1.35	1.31	1.26	1.21	1.16		1.04	
25		1.30		1.19	1.13	1.08	1.03	0.98		
Monthly means		**1.45**	**1.42**	**1.32**	**1.24**	**(1.14)**	**(1.10)**	**(0.98)**	**(1.04)**	
Departure from 6-year normal		**−0.05**	**−0.04**	**−0.05**	**−0.08**	**−0.11**	**−0.10**	**−0.16**	**−0.06**	
P. M.										
Mar. 9		1.56								
15	[1.54*]	1.47	1.38	1.30	1.23	1.15	1.08	1.02	0.96	0.91
16		1.47	1.41							
18		1.55								
22		1.43								
23	[1.43*]	1.38	1.31	1.24	1.17	1.11	1.05	1.01		0.92
30		1.33								
Monthly means		**1.46**	**1.37**	**(1.27)**	**(1.20)**	**(1.13)**	**(1.06)**	**(1.02)**	**(0.96)**	**(0.92)**
Departure from 2-year normal		**±0.00**	**−0.01**	**−0.01**	**−0.03**	**−0.03**	**+0.03**			

* Extrapolated and reduced to mean solar distance.

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C.			Madison, Wis.			Lincoln, Nebr.			Santa Fe, N. Mex.		
Dates.	8 a.m.	8 p.m.	Dates.	8 a.m.	8 p.m.	Dates.	8 a.m.	8 p.m.	Dates.	8 a.m.	8 p.m.
1918.	*mm.*	*mm.*	1918.	*mm.*	*mm.*	1918.	*mm.*	*mm.*	1918.	*mm.*	*mm.*
Mar. 2	3.15	4.57	Mar. 1	1.96	3.15	Mar. 1	2.26	4.37	Mar. 1	2.36	4.17
4	3.30	4.75	2	3.45	3.15	7	2.26	2.87	4	3.45	3.81
7	6.02	3.00	7	2.26	3.63	16	2.87	3.53	9	3.15	3.15
8	3.45	3.15	15	1.32	2.26	19	2.49	3.63	14	2.26	2.16
11	1.78	3.15	16	2.62	4.17	21	6.50	3.81	15	2.49	2.26
16	2.49	3.45	19	3.45	5.79	24	3.63	3.81	16	2.26	2.16
18	3.81	5.36	22	3.15	3.30	25	3.15	3.63	18	2.62	1.96
23	3.63	3.99	26	3.30	3.30	27	3.81	5.79	22	3.00	4.95
25	6.02	1.68	27	3.00	2.74	....	....	....	23	3.81	4.37
26	2.62	2.26	28	3.15	4.57	....	....	....	25	3.45	3.99
27	2.49	3.15	....	....	....	....	....	....	30	4.37	3.45
28	3.45	3.81	....	....	....	....	....	....	....	....	....
29	3.63	4.37	....	....	....	....	....	....	....	....	....

TABLE 3.—*Daily totals and departures of solar and sky radiation during March, 1918.*

[Gram calories per square centimeter of horizontal surface.]

Day of month.	Daily totals.			Departures from normal.			Excess or deficiency since first of month.		
	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
1	72	443	464	−223	145	113	−223	145	113
2	428	397	412	129	95	58	−94	240	171
3	467	414	131	165	107	−227	71	347	−56
4	185	179	365	−121	−132	4	−50	215	−52
5	365	139	114	56	−176	−251	6	39	−303
6	251	125	294	−61	−193	−74	−55	−154	−377
7	368	408	435	53	86	65	−2	−68	−312
8	443	165	310	125	−160	−63	123	−228	−375
9	76	16	205	−245	−312	−170	−122	−540	−545
10	293	455	468	−31	123	90	−153	−417	−455
11	457	331	430	130	−4	50	−23	−421	−405
12	84	350	430	−246	12	47	−269	−409	−358
13	41	35	203	−292	−306	−182	−561	−715	−540
14	47	239	256	−289	−105	−132	−850	−820	−672
15	419	526	445	80	179	55	−770	−641	−617
16	521	534	502	180	184	109	−590	−457	−508
17	370	456	472	26	104	77	−564	−353	−431
18	467	419	....	121	64	....	−443	−289	−431
19	415	472	541	66	114	142	−377	−175	−289
20	412	424	371	61	64	−31	−316	−111	−320
Decade departure							**−163**	**+306**	**135**
21	63	289	492	−291	−74	88	−607	−185	−232
22	350	462	499	−6	96	93	−613	−89	−139
23	528	505	491	169	137	−7	−444	48	−146
24	421	493	494	60	122	84	−384	170	−62
25	486	315	528	122	−59	116	−262	111	54
26	428	473	508	62	97	94	−200	208	148
27	532	551	488	163	173	73	−37	381	221
28	454	528	316	83	147	−101	46	528	120
29	539	461	391	165	78	−28	211	606	92
30	450	493	486	74	108	66	285	714	158
31	474	342	469	95	−45	47	380	669	205
Decade departure							**+696**	**+780**	**+525**
Excess or deficiency since first of year: Gram calories							**+517**	**+1,538**	**−550**
Excess or deficiency since first of year: Per cent							+2.3	+6.7	−2.0

A PROMISING CHEMICAL PHOTOMETER FOR PLANT PHYSIOLOGICAL RESEARCH.

By CHARLES S. RIDGWAY, Assistant.

(Office of Tobacco and Plant Nutrition Investigations, Bureau of Plant Industry, United States Department of Agriculture.)

[MS. received by Weather Bureau, Apr. 10, 1918.]

Botanical literature is replete with references regarding the effect of light upon plants from the viewpoint of the physiologist, the anatomist, the histologist, the ecologist and the agriculturist. Numerous methods and instruments have been devised and used, and with some success, for the determination of the intensity or nature, or both, of the insolation of the plant under observation. So far as the writer is aware, all of these methods and instruments are possessed of objectionable limitations, either in reliability, initial cost, or cost of operation. It seems advisable, therefore, to call attention to a photometer which, at the present stage in its trial, at least indicates its practicability in connection with investigations of the light relations of plants. Allusion is had to the use of oxalic acid and uranium salts as advocated by Dr. Raymond F. Bacon.[1]

Through the courtesy of the United States Weather Bureau, and with the kind cooperation of Prof. H. H. Kimball of that bureau, some comparisons have been made of the records obtained by the Callender recording pyrheliometer with the results of exposure of the chemical photometer, with the idea of standardizing the latter.

In testing out the chemical photometer, the writer used uranium acetate and oxalic acid in the proportions of 1 part by weight of the former to 20 of the latter; that is, 5 cubic centimeters of a 1 per cent (0.023 molecular) aqueous solution of the uranium salt to 20 cubic centimeters of a 5 per cent (0.71 molecular) aqueous solution of the acid. (In most of his experiments Dr. Bacon used a proportion of 1 to 10. In the present tests, however, the amount of oxalic acid was increased in order that long exposures might be made.) The solutions were brought together in Florence flasks of 100 cubic centimeters capacity, plugged with loose wads of cotton,[2] and the flasks so adjusted in holes in a blackened board that the surface of the liquid in each flask was flush with the upper surface of the board, the neck of the flask being inclined to the north so that no shadow would be cast upon the liquid. This method of excluding the light from the sides of the flask was adopted in order that only the horizontal surface of the liquid would be exposed to the sunlight and thereby be more nearly comparable with the horizontally exposed receiving portion of the pyrheliometer. After exposure the oxalic-acid-uranium-acetate mixture was titrated with potassium permanganate (2N solution) in the following manner: The mixture was increased to a convenient volume for titration, either in the original flask or after having been transferred to a beaker, by the addition of distilled water. The volume to be titrated was then heated to 70° C., made strongly acid by the addition of 1:1 sulphuric acid and the potassium permanganate end point determined while the solution was still hot. Though Dr. Bacon states that he removed the uranium salt before titration by the addition of a slight excess of ammonium hydrate, the writer found that aliquots of the same solution gave no differences in the amount of oxalic acid present, whether the uranium was removed or not, and, therefore, did not use the ammonium hydrate. It was found that in cool weather a 10 per cent solution of oxalic acid became supersaturated, when the temperature dropped during the night, to such an extent that the stock bottle contained crystals the following morning when it was desired to make up fresh mixtures for exposure. Because of this fact it was necessary to use double the quantity of a 5 per cent oxalic acid solution.

A series of 13 comparisons of the chemical photometer with the pyrheliometer was run during the months of May and June, 1917. The length of exposure of the solution ranged from 8 to 24 hours, although in most cases the flasks were first exposed after dark in the evening and taken in after dark the next evening,

[1] *Bacon, R. F.* A solution of oxalic acid and uranium salts as a chemical photometer. Philip. jour. sci., A, Manila, 1910, 5: 281–303.

[2] The flasks could not be completely closed since Dr. Bacon says: "For all practical purposes the decomposition of oxalic acid under the influence of uranyl salts may be assumed to take place as follows: $H_2C_2O_4 \rightarrow CO_2 + CO + H_2O$." Some outlet, therefore, was necessary for the escape of the gases generated.—*Author.*

giving an exposure of a full 24 hours. The ratio, $\frac{\text{calories recorded by pyrheliometer}}{\text{grams oxalic acid decomposed}}$ for each exposure, the mean ratio of all the exposures, and the percentage departure of each from the mean were computed. It was found that, with a mean of 978 for all the exposures, in nine cases the deviation from the mean ranged between 0.2 and 3 per cent on either side, and that of the four other exposures, one was 6 per cent below the mean and three were 5, 7, and 8 per cent above, respectively.

Tests to determine the stability of the oxalic-acid-uranium-salt mixture in the dark, both before and after exposure, were made repeatedly and indicated that no appreciable decomposition of the oxalic acid takes place within three days if the mixture is kept in a dark closet. The effect of the diffuse light of the laboratory was also tested. The results showed that it would be necessary to expose the photometer for several hours in order to effect a measurable decomposition of oxalic acid when the proportions mentioned above are used. The temperature coefficient of the reaction was disregarded, since Dr. Bacon states that for a remarkably wide range of temperatures this factor need not be considered.

One application of the chemical photometer was demonstrated, at least to the satisfaction of the writer, in determining with it the transmission coefficient of a piece of tobacco shade cloth of 12×12 mesh in connection with investigations of the light relations of the tobacco plant. A flask containing the mixture was exposed (from 9.30 a. m. to 2.30 p. m. on March 21, 1917, a cloudless, bright day) to the sunlight which passed through the cloth stretched over the south side and top of a small frame. During the same period a second flask was exposed to uninterrupted sunlight and a third to the light of a portion of the northern sky together with some reflected light from a low white wall opposite the north window in which the last-mentioned exposure was made. At the end of the 5 hours the contents of the three flasks were titrated and the decomposition of oxalic acid (0.229 gram) in the fully insolated mixture was taken as 100 per cent. The decomposition in the shaded flask (0.121 gram) showed that in passing through the cloth the photochemical effect of the light as measured by this reaction had been reduced to 47.2 per cent. The decomposition in the flask exposed to the north light was 0.029 gram, or 12.6 per cent of that which took place during the same time in the flask in direct sunlight. The figure for the transmission of the shade cloth is nearly the same as the coefficient determined by Prof. Kimball[3] with the use of the Smithsonian silver-disk pyrheliometer (42.7 per cent at normal incidence) when it is considered that the flask under the cloth was subjected to considerable reflected light from a white wall during the exposure. The same is true of the flask exposed in a north window—that is, the percentage of total light (12.6 per cent) also includes some reflected light from the wall to the north of the flask.

Experiments to determine the reliability of the solutions and the accuracy of titration of the oxalic acid showed, by the use of series of duplicate flasks exposed simultaneously, that there were no differences beyond an experimental error of ±1 per cent. The results of further experiments conducted for the purpose of measuring the intensity of the sunlight on clear days, hour by hour, produced a curve very similar to the records obtained with the pyrheliometer. This was true whether separate exposures of an hour each were made or aliquots were taken at the end of each hour from a continuously exposed volume of the oxalic-acid-uranium-acetate mixture.

From the tests outlined above, this chemical photometer seems to be affected by light in a degree comparable to the pyrheliometer in spite of the fact that the two instruments doubtless are influenced by different portions of the solar spectrum. Dr. Bacon cites several published articles tending to show that solutions of both uranium salts and oxalic acid produce absorption bands in that region of the spectrum characterized by short wave lengths, and makes the statements: ". . . . it may be considered as being fairly well established that the active rays from the sun measured by this solution are in the ultra-violet," and further ". . . . I do not consider that there is any good reason for classifying the sun's rays into infra-red or heat rays, visible rays, and ultra-violet or chemical rays, as there are just as many chemical reactions effected by light corresponding to the visible and even infra-red parts of the spectrum as there are by the ultra-violet portion." In Bacon's Table V, however, the decomposition in a solution exposed in a quartz beaker was somewhat less than that in a similar solution exposed at the same time in a glass flask. Since the reaction does take place in a glass container, it seems probable that rays other than the ultra-violet, are active upon the solution. This seems even more certain when it is considered that of the total range of ultra-violet light (3,920—1,000 Ångström units) only those over 2,910 Å. in length reach the earth and that none less than 3,000 Å. are capable of passing through glass. It should be stated further that the rays over 3,000 Å. in length are not bactericidal and, hence, are probably the least active chemically of the ultra-violet portion of the spectrum so far as living organisms are concerned.[4]

Granting that the chemical photometer shows the chemical effect of light belonging chiefly to the violet end of the spectrum and that the pyrheliometer records the heating effect of the entire spectrum, with its maximum in the infra-red, it seems, from the comparisons made, that the proportion of the two kinds of rays commonly obtaining in ordinary sunlight is responsible for the apparent agreement of the two methods of measurement in a majority of the tests. The cases of marked departure of the ratio $\frac{\text{calories}}{\text{grams}}$ from the mean of all the observations are thought to be due in most instances to the occurrence of clouds or haze which affected the intensity of the rays at one end of the spectrum to a greater extent than those at the other end. It may be stated, however, that Professor Kimball thought it advisable to discard some of the comparisons made because of the presence during the exposure of moving cumulus clouds which caused the recording pen of the pyrheliometer to move so rapidly that accurate evaluation of its curve was impossible. Another explanation of apparently discordant results lies in the fact that instruments of the recording pen type are liable to considerable error by lagging, especially when actuated by widely different impulses of short duration occurring in rapid succession, such as the effect of moving clouds just mentioned.

Until the question of the specificity of the physiological effect upon plants of light rays of different wave lengths is settled to the satisfaction of plant physiologists, it seems to the writer that a means of light measurement in

[3] See *Kimball, H. H.*—The shading effect of wire insect cages, MONTHLY WEATHER REVIEW, September, 1916, **44**: 501-506, for a description of his method of determining shading effect.

[4] *Ayers, H. S. & Johnson, W. T.* Destruction of bacteria in milk by ultra-violet light. Centbl. Bakt. (etc.) Abt. 2: Bd. **40**; 1914, No. 1/8 pp. 109-131.

general by a chemical method is greatly to be desired. The spectrum of chlorophyll solution shows definite absorption bands in the red and orange and almost general absorption in the blue, indigo, and violet with smaller bands interspersed in other portions. The projection of the solar spectrum for some hours upon a leaf has demonstrated that photosynthesis takes place most prominently in the region of the red and to some extent at other points, though few acceptable results indicating the effect of light of various wave lengths upon other life processes of the plant have been stated.[5] As far as light is concerned physiological investigations deal, in the main, with that factor in its totality, its effect upon plants being generally regarded as photochemical; hence, the feasibility of the chemical method of measurement herein described, should future investigations confirm its seeming usefulness.

Some of the probable advantages of the method are the ease and low cost with which it may be operated, the avoidance of complicated, costly and frequently unreliable mechanisms, and the reduction of error due to the personal factor in observation, so prominent in the photographic paper method. The chief values of the chemical photometer, however, if its reliability is established, will lie in the facility with which several exposures may be be made simultaneously under various degrees of illumination and the fact that the solution gives an automatic integration for the time period of exposure. The automatic exposure of vessels containing light sensitive solutions by the use of clocks has been accomplished by Stone[6] and a similar arrangement may be advantageous in connection with the one just described. Though plans are made for further work with the oxalic-acid-uranium-salt photometer during the coming growing season, it is hoped that it will be carefully investigated in its application to problems in plant physiology, especially with reference to the correlation of its properties with the various life processes, since such research, though attractive, lies without the province of the writer in his present field of activity.

FURTHER STUDY OF HALOS IN RELATION TO WEATHER.

By HOWARD H. MARTIN, Observer.

[Dated: Weather Bureau, Columbus, Ohio, March 4, 1918.]

Since 1907 several papers have been prepared on the subject, based on data from isolated stations, and it is the desire of the writer to present herewith, in conjunction with the results obtained at Columbus, Ohio, the collected results of all observations over the United States and to show the possible relation between these results and latitude, longitude, and the average cyclonic tracks.

Blue Hill, Mass. Blue Hill Observatory.

Lat., 42° 21′ N.; Long., 71° 4′ W. (approximate).

Number of observations, 569, of which 467 were solar and 102 were lunar. Month of greatest frequency: solar halos, average 5.9 in March; lunar halos, average, 2.7 in January. Month of least frequency, solar, average 2.3 in October; lunar, 0.4 in July.

Wauseon, Ohio. Thomas Mikesell, observer.

Lat., 40° N.; Long., 84° W.

Length of record, 1873–1912, inclusive. Total number of halos observed, 2,918, of which 2,219 were solar and 699 were lunar. Month of greatest frequency, April, average 9.2; least, August, average 3.2.

Fort Worth, Tex. Weather Bureau.

Lat., 32° 43′ N.; Long., 97° 15′ W.

Length of record, 1910–1915, inclusive. Total number observed 170, of which 86 were solar and 84 were lunar. Month of greatest frequency, January, average 4.0; month of least frequency, September, 0.3.

York, N. Y. Milroy N. Stewart, observer.

Lat., 42° 52′ N.; Long., 77° 53′ W.

Total number of halos observed 372, of which 317 were solar and 55 lunar. Month of greatest frequency, March, average 3.4; least, June, average 2.1.

Lake Montebello, Md. Martin L. Dobler, observer.

Approximate lat., 39° N.; Long., 76° W.

Total number of 17 observed from November 5, 1905 to December 26, 1906, of which number 9 were solar and 8 lunar.

Columbia, Mo. Weather Bureau.

Lat., 38° 57′ N.; Long., 92° 20′ W.

The period of observation was approximately two years, during which time 40 halos were observed, of which number 37 were solar and 3 were lunar. The month of greatest frequency was January, least, July and August.

Columbus, Ohio. Weather Bureau.

Lat., 39° 58′ N.; Long., 83° 0′ W.

Period of observations extends from January 1, 1906 to December 31, 1917, during which time 185 were observed, of which 83 were solar and 102 lunar. Month of greatest frequency, April, 2.4; least, August, 0.2.

The record at Columbus, Ohio, in point of numbers observed, is not as complete, apparently, as it might be, but this is largely due to the generally smoky condition of the atmosphere. In Table 1, showing the general relation to precipitation of halos at this station, no attempt is made to discriminate between the solar and the lunar, sparsity of observations prohibiting. A striking similarity may be noted in the record at this station and the record of Wauseon, Ohio, of the months of greatest and least frequency. During the 12 years record at Columbus, but one halo was observed during the month of August.

TABLE 1.—*Relation existing between halos and subsequent precipitation, at Columbus, Ohio, 1906–1917, inclusive.*

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Number considered	16	20	24	35	18	7	4	1	5	12	17	18	*181
Per cent followed by precipitation—													
In 18 hours	50	25	46	63	77	28	50	100	60	42	53	50	54
In 24 hours	69	40	58	74	77	43	75	100	60	59	60	67	65
In 36 hours	81	60	65	80	83	57	75	100	100	67	65	72	75
In 48 hours	94	65	75	88	89	71	100	100	100	75	82	88	86
Not followed within 60 hours	6	30	17	11	11	14	0	0	0	17	12	6	8
Average interval between halo and precipitation	23.7	44.4	33.4	24.6	17.2	40.3	20.5	11.4	16.9	28.2	29.7	24.3	26.2
Average duration of halo	1.9	2.4	1.7	1.6	1.4	1.2	2.5	2.5	1.6	1.3	1.6	1.5	1.8

* Four halos not considered because of incomplete data.

Table 2 shows all stations arranged according to latitude and longitude, and presents the relative value of the halo as a rain forecast for the several localities. There are indications of a possible maximum percentage of verifications in the higher latitudes, increasing as the longitude decreases.

[5] *Richter, A.* (in Rev. Gen. de Bot., 1902, p. 212) indicates that the amount of photosynthesis in a leaf subjected to monochromatic light, is a function of the heat energy of that light and independent of its wave-length. Recent articles published by Dr. S. O. Mast in the Journal of Experimental Zoology, deal with the stimulating effect of different spectral colors on lower organisms. The bactericidal action of ultra-violet rays, which must be a function of wave length rather than heat, is well established (Ayers, see footnote 4).

[6] *Stone, G. E.* Relation of light to greenhouse culture. Mass. Agri. Expt. Sta. Bull. 144, July, 1913. (Though the results of measurements of light by a photochemical method are stated, the details of the method are not given.)

TABLE 2.—*Percentages of verification in halo-rain forecasts for stations, arranged according to latitude and longitude.*

Station.	Longitude.	Latitude.	24-hour.	36-hour.	48-hour.	60-hour.	Average interval.
	° W.	° N.					
Fort Worth, Tex	97	34	36	48	59	68	24.1
Columbia, Mo	92	39	24	......	49	59	....
Wauseon, Ohio	84	42	58	......	......	......	....
Columbus, Ohio	83	40	65	75	86	92	26.2
York, N. Y	78	43	64	......	83	......	17.3
Lake Montebello, Md	76	39	11	......	67	......	....
Blue Hill, Mass	71	42	......	68	......	......	15.6

While there is an increase of percentages of verification eastward to approximately longitude 80° West, there is also an appreciable falling off as the Atlantic coast is approached. With this in mind, reference to a map of storm tracks (e. g. supplement 1, chart 1) would indicate that the percentages of verification will increase, not so much with latitude or longitude but with the proximity of the observation point to one or more of the storm tracks. The chart showing the weighted, or average cyclonic tracks for January will apply to the months of greatest frequency as well, especially in the northern districts. It will be noted that the eastern stations lie between the paths, or upon the common path of practically all the storms that cross the United States and that Fort Worth, Tex., and Columbia, Mo., are far south of the tracks of the more frequent types. A large percentage of the precipitation occurring over these districts is due to cyclones of either the South Pacific or Texas type, relatively infrequent.

As outlined in previous papers, it has been found at Columbia, Mo., that "22-degree circles are followed by precipitation within 12 to 18 hours, the storm crossing the meridian near the point of observation; (2), when the 45-degree circle is observed, the storm center is usually from 800 to 1,000 miles away and precedes precipitation, if any, by 24 to 36 hours." These deductions were based on the consideration of a relatively small number of observations.

The larger percentage of LOWS affecting the weather at Fort Worth, Tex., pass far to the northward of that station. It was found that quite frequently during the winter months, the center remained so far north as to leave the sky veiled with cirrus and cirro-stratus for from 24 to 48 hours at a time. In cases of this kind, halos occurred slightly in advance of the wind-shift line and were fairly good prognosticators of advancing cold. They were usually followed by "northers" within 24 hours and rarely by precipitation.

At Wauseon, Ohio, a relation was determined between the percentage of verification and the atmospheric pressure. Kirk found that with the pressure below normal and falling, 83 per cent of observed halos were followed by precipitation within 24 hours; that, with the barometer low, but rising, but 53 per cent were followed by rainfall within the prescribed period, and that with the pressure above normal and rising, 63 per cent were followed by fair weather.

A marked relation must, of course, exist between the verification of the halo forecast and the prevailing direction of the wind, the probability of rain increasing with the change to the quarter most often accompanied by precipitation. Thus, at Fort Worth, it was found that 94 of the 99 halos followed by rain or snow within 48 hours were attended or followed by easterly winds and falling pressure. Of the 94 halos so observed, 82, or 87 per cent, were followed by precipitation by the end of the succeeding day. Like conditions appear to exist at Wauseon, Ohio, with southerly winds, and at York, N. Y., with southwest winds. At Columbus, 88 per cent of the halos preceding precipitation by 48 hours were accompanied or followed by southwest winds.

So, with all these facts well in mind, it must be said that the halo indicates the approach of precipitation only in so far as it heralds the approach of the cyclone. To only the extent that the passage of the cyclone affects the weather at the station, is the halo reliable. With knowledge of the condition of the barometer, whether rising or falling, and knowing which direction of the wind most often precedes precipitation, the layman may know what degree of faith to place in the celestial harbingers; but, without this knowledge, he will often have occasion to fall back upon the old adage, "All signs fail in fair weather." The halo is a faithful detector of cyclonic presence; the pressure and wind indicate the cyclone's approach and passage, and a just consideration of these three elements will go far to establish the halo, not as a promise of rain or storm, but as a warning that somewhere far to westward a cyclone is advancing. In this point alone the halo excels.

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(3) Halos and their relation to the weather, by A. H. Palmer. 6 p. Monthly Weather Review, Washington. 42 : 446.

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(8) Halo observations at York, N. Y., by Milroy N. Stewart. Washington, Monthly Weather Review. 43 : 444.

(9) Halos and rain or snow, by Martin L. Dobler. Washington, Monthly Weather Review. 35 : 227.

REMARKABLE HALO OBSERVED AT NASHVILLE, TENN., MARCH 16, 1918.

By R. M. WILLIAMSON, Meteorologist.

[Dated: Weather Bureau, Nashville, Tenn., Mar. 29, 1918.]

An interesting and unusual form of solar halo was observed at this station on March 16. It was first seen as a faint fragment of the usual 22-degree circle at 8:45 a. m. (90th meridian time). An hour or more later it appeared as a complete circle, though ill-defined and presenting no unusual features. At 11:45 a. m. the attention of the station force was called to a remarkable series of rings about the sun, and the coloring and arrangement of the circles were so distinct as to attract wide attention. The phenomenon continued, although in changing form, until about 5:30 p. m.

Unfortunately, no instruments were available with which to determine angular distances, but a comparison of this halo with figures outlined in Besson's "Different Forms of Halos" leaves little doubt as to the correctness

of the terms used in the following sketch, which gives roughly the arrangement of the circles and the attending features as observed about noon.[1]

The display was most brilliant from 11:45 a. m. to 12:15 p. m., the prismatic colors being unusually strong

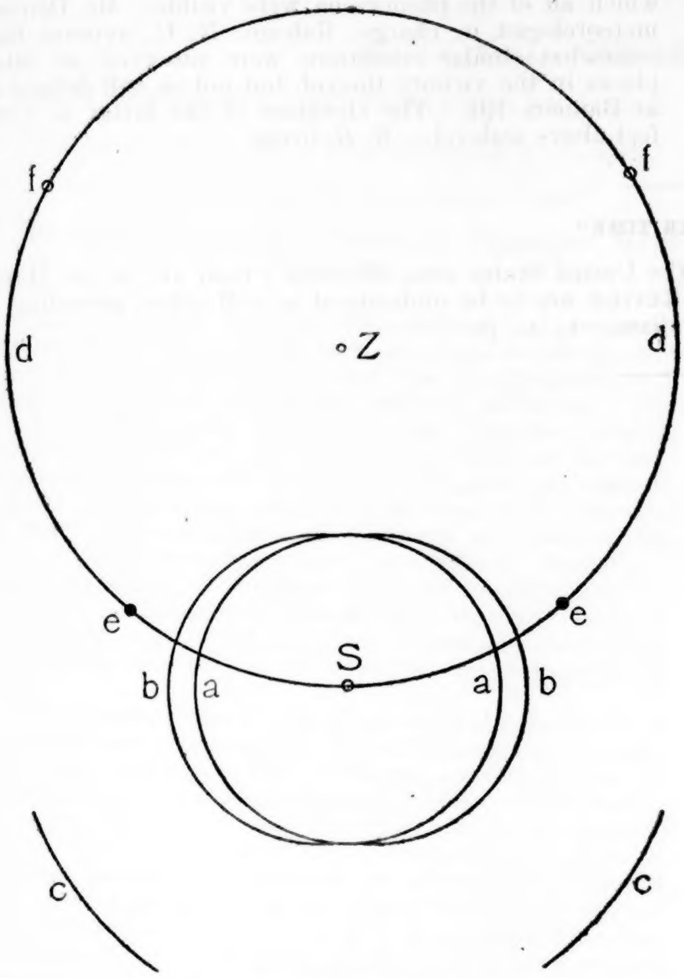

FIGURE 1.—Halo phenomena observed at Nashville, Tenn., March 16, 1918.

Ordinary halo of 22° (*aa*); circumscribed halo (*bb*); arcs of halo 46° (*cc*); parhelic circle (*dd*); ordinary parhelia of 22° (*ee*); paranthelia of 120° (*ff*); sun (*S*); zenith (*Z*).

in the upper and lower quarter arcs of the ordinary and the circumscribed halos, and fairly clear in the remaining portions of the phenomenon, except the parhelic circle, which showed no coloring. There was noted, however, in the parhelic circle at least two spots, or "knots," of white light brighter than the remaining portion of the circle, probably the ordinary paranthelia of 120 degrees (shown in the figure on p. 20 of Besson's pamphlet). The ordinary and cirumscribed halos were distant from each other about three or four degrees at the points of greatest separation on either side of the sun. The fragments (*cc*) of the halo of 46° did not stand out clearly at any time and were not visible after 12:15 p. m. The rings, however, continued complete, though with decreasing brilliancy, until after 2 p. m. By 3 p. m. the sheet of cirro-stratus clouds had become considerably denser and only the ordinary 22-degree halo appeared. At 3:50 p. m. the ordinary parhelia of 22° were again plainly visible, and at this time very close to the 22-degree circle, although when observed about noon they stood well outside (probably 5 degrees from) the cirumscribed halo.

At 4:30 p. m. there was added a still further interesting feature, namely, the circumzenithal arc, distinctly colored, and probably, although this was not positively determined, an arc of the halo of 46° tangent thereto. The latter was not so well defined as the circumzenithal arc, but its determination is believed to have been correct, especially in view of the observation about noon of its two fragmentary arcs. The circumzenithal arc and its accompanying tangent continued for 10 minutes or more. At 5:20 p. m. there was still visible a small upper arc of the ordinary 22-degree halo, and at 5:30 p. m. the phenomenon had disappeared entirely.

[1] The Besson pamphlet referred to is the 8-vo separate of the translation *Besson, L.* Different forms of halos and their observation, MONTHLY WEATHER REVIEW, Washington, July, 1914, 42: 436-446.

SOLAR HALO PHENOMENA OBSERVED MARCH 16, 1918, AT BANNERS ELK, N. C.

By T. L. LOWE, Local Observer.

(Forwarded by Mr. L. A. Denson, Meteorologist in charge, Raleigh, N. C.)

On March 16, 1918, at Banners Elk, N. C., there occurred one of the most peculiar celestial phenomena ever observed here. The thermometer registered 18°F. above zero. At about 8 a. m. there was a haze in the sky and there appeared a complete circle of luminous

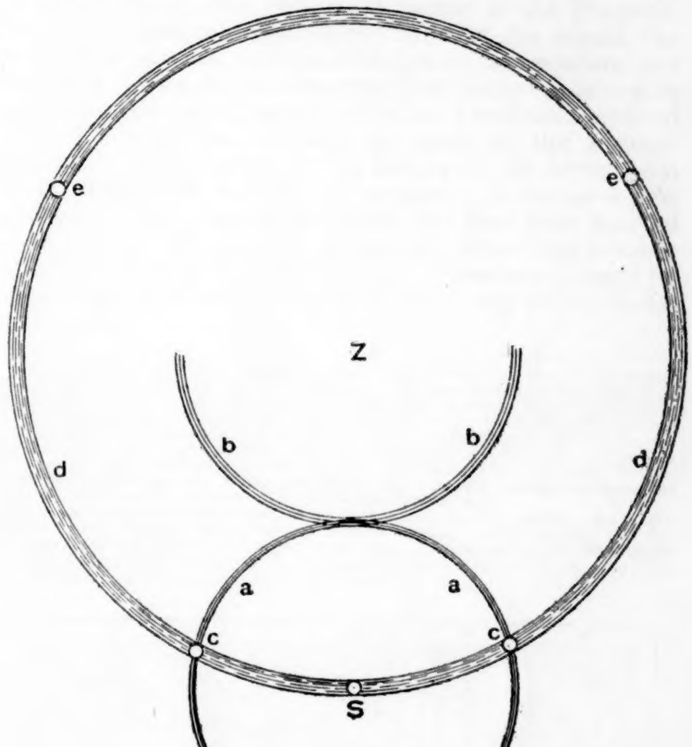

FIGURE 1.—Solar halo phenomena observed March 16, 1918, at Banners Elk, N. C.

aa, 22-degree solar halo; *bb*, upper tangent arc of 22-degree halo; *cc*, parhelia of 22°; *dd*, parhelic circle; *ee*, paranthelia of 120°; *S*, Sun; *Z*, zenith.

light around the sun with two distinct mock suns on either side, as shown in the diagram (fig. 1). Above this circle and tangent to it was a semicircle, and all around

the zenith at the altitude of the sun was a large circle of white light as shown in the diagram. The smaller circle and the semicircle tangent to it had all the prismatic colors, while the large circle was white. There were two distinct spots of white light on the outer rim of the large circle and these showed plainly for several hours. This circle gradually diminished in size as the sun rose toward the zenith. It lasted from about 8 a. m. until late in the afternoon. The mock suns followed the sun all day and were visible until about 4 p. m., when clouds became so dense that they were no longer to be seen.

NOTE.—In figure 1 Mr. Lowe presents a sketch of solar halo phenomena as they appeared at about 8 a. m. This figure and Mr. Lowe's description are of interest chiefly in the indicated length of the upper tangent arc of the 22-degree halo and in the length of time during which all of the phenomena were visible. Mr. Denson, meteorologist in charge, Raleigh, N. C., reports that somewhat similar conditions were observed at other places in the vicinity thereof, but not so well defined as at Banners Elk. The elevation of the latter is 3,750 feet above sealevel.—*W. R. Gregg.*

"SUMMER TIME"

According to the Daylight-saving Act the clocks of the United States were *advanced* 1 hour at 2 a. m. March 31, 1918; the observations recorded in this issue of the REVIEW are to be understood as still taken according to Normal Standard Time for the respective standard meridians.—C. A., jr.

SECTION II.—GENERAL METEOROLOGY.

SOLAR DISTURBANCES AND TERRESTRIAL WEATHER.*

By ELLSWORTH HUNTINGTON, Research Associate in Geography.

[Dated: Yale University, New Haven, Conn., Mar. 7, 1918.]

I. EXTREME BAROMETRIC GRADIENTS COMPARED WITH SUNSPOTS.

The connection between disturbances in the atmospheres of the sun and the earth has been so widely, and often so intemperately discussed that no thoughtful student can approach the subject without diffidence. The work of Newcomb, Köppen, Hann, Lockyer, Veeder, Arctowski, Bigelow, Hildebrandsson, Kullmer, Hellard-Hansen, Nansen, and many others suggests an intimate connection between solar disturbances and terrestrial weather. Nevertheless, all attempts to discover the nature of the connection have been baffled. Sometimes the appearance of sunspots seems to be the signal for pronounced barometric disturbances in many parts of the world. At other times when sunspots are equally numerous, changes in the weather are conspicuously rare.

The present series of papers presents the results of an investigation of the relation between barometric pressure and solar activity. The terrestrial conditions are determined by a new method marked by two chief characteristics: (1) The work is based on individual days instead of the month and year as in most investigations. (2) The barometric conditions are expressed in terms of the average gradients, that is, the average distance from one isobar to another, instead of being expressed in terms of pressure. Thus all parts of a given map receive equal consideration, and undue emphasis is not given to specific stations.

The solar conditions include sunspots, faculæ, and the solar constant. The sunspots are not reckoned in terms of their total area as is usually the case, but in terms of the *spottedness in specific parts* of the solar disk. As the final result of this investigation it appears that one of the most important solar conditions is the *difference* between the spottedness in corresponding areas on different portions of the sun's disk. A concrete example will illustrate the matter. Suppose that on three successive days the total sunspot areas are as shown in column A, while the eastern and western thirds of the sun's disk have the sunspot areas shown in columns B and C. The difference between B and C is shown in D. It increases from the first day to the third, whereas the total spottedness decreases.

	A.	B.	C.	D.
	Total sunspot area.	Sunspot area of sun's eastern third.	Sunspot area of sun's western third.	Difference between areas of B and C.
First day	500	150	130	20
Second day	300	60	110	50
Third day	120	0	100	100

* Purchased and published by order of the Chief of Bureau.

This method of "solar differences" is the final outcome of some 50 or 60 trials. Most of the trial methods indicated some sort of relation between the earth and the sun. One after another, however, was discarded because it led to inexplicable contradictions. The method finally adopted reduces such contradictions to small proportions, but does not entirely eliminate them, so that it can not be regarded as final. In this first paper it will be explained and illustrated. In later papers it will be amplified and will be tested by other methods.

Method of computing the barometric gradients.—Since maps of barometric gradients are perhaps the best general method of illustrating the weather conditions at any given time, it seems appropriate to employ them in the present investigation. So far as the weather is concerned, the most important fact is not so much whether the barometric pressure is high or low, but whether the pressure differs much or little from that which prevails a few hundred or a thousand miles away. In other words, the important factor is the gradient. On this, in general, depend the force of the winds, the violence of storms, and the changes in temperature and humidity. The barometric gradient between two specific points can easily be computed by a well standardized method. It is not so easy to compute the average gradient of large areas, for it has rarely or never been done. Therefore, it has been necessary to devise a new method. After various attempts the best plan seemed to be to use daily weather maps, and count the number of intersections of isobars with the degree net formed by every fifth meridian of longitude and every fifth parallel of latitude.[1]

[1] In the preliminary investigations the daily weather maps of the United States, the Atlantic Ocean, and Europe were employed. It later became evident that high pressure areas should be separated from those with low pressure. Therefore attention will be confined to the North Atlantic Ocean which can readily be divided into a stormy northern area of low pressure, and a southern area of high pressure and few storms. The best maps of the North Atlantic are those of the German Admiralty. (Kaiserlich Marine. Deutsche Seewarte. Internationaler Dekadenbericht. Tägliche Wetterkarten des Nordatlantischen Ozeans, 1904–1913.) Their general outlines are illustrated in fig. 1. The isobars are drawn at intervals of 5 millimeters.

The maps used in the preparation of this article were most courteously put at my disposal by the Weather Bureau through its Boston office, and by the Blue Hill Observatory through its director, Prof. A. G. McAdie. In counting the gradients of the United States I was assisted by Mr. L. W. Carroll of the Boston Weather Bureau office to whom it is a pleasure to express my gratitude.

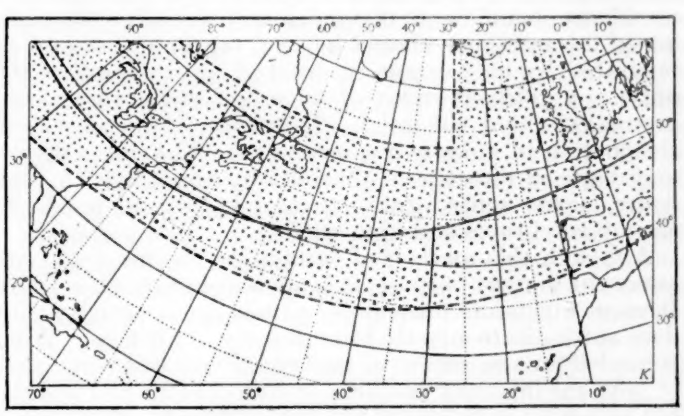

FIGURE 1.—North Atlantic Ocean as shown on the daily charts of the Deutsche Seewarte Internationale Dekadenberichte. Stippled area indicates stormy portion of the ocean and neighboring lands.

The method can best be illustrated by an example. Fig. 2 shows the map for January 8, 1912, when a marked cyclonic area was central in latitude 50°N. and longitude 40°W. We begin our count with the 65th parallel which is intersected three times, namely, by the isobars 750, 755, and 760, (1000 mb, 1007 mb, and 1013 mb).

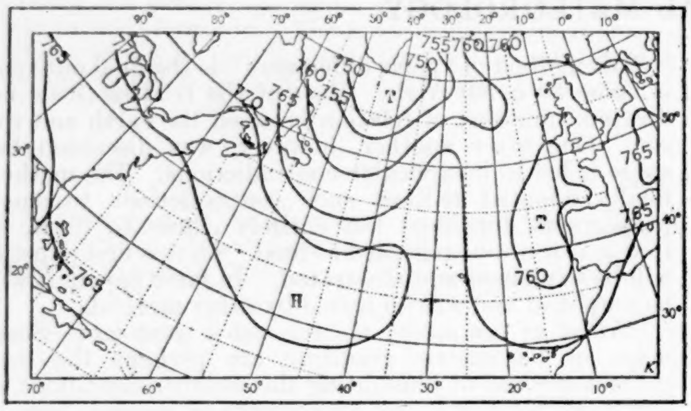

FIGURE 2.—Distribution of pressure over the North Atlantic on Sept. 8, 1911, 8 a. m. (Deut. Seewarte Internat. Dekadenber. No. 403 [Hamburg, 1911.])

The 60th parallel is intersected 6 times by isobars from 740 to 765, (987 to 1020 mb), making a total of 9. Then comes the 55th with 8 intersections, and the 50th with 18 provided all the isobars that must cross the parallel are prolonged until they actually do so. The 45th parallel is crossed and recrossed by the isobar marked 750 (1000 mb), so that these two lines show three intersections in the space of 15°. The next isobar, however, has no intersection with the 45th parallel for the space of 35°. Thus one balances the other. The total number of intersections for the 45th meridian is 14. This, it will be noticed, is obtained by prolonging the parallel over the land although it is not drawn on the map. The total number of intersections of the isobars with the parallels is 76. Counting the intersections with the meridians in the same way we get 111, making a total of 187. This is the "gradient index" for January 8, 1912. The normal for that particular day, as obtained from smoothed 10-year means, is 168. Therefore when the index is reduced to percentages of the normal it figures as 111.

The concrete significance of the gradient index may be estimated by measuring the length of the parallels and meridians and dividing that length by the number of intersections. If the total length of the parallels and meridians should be 40,000 miles and the index, or number of intersections, should be 100, the isobars would be separated by an average interval of approximately 400 miles. A gradient index of 50 would mean an average interval of about 800 miles. For practical purposes such a reduction to miles is not necessary. The index figures may be used directly as obtained by counting. A high figure means a high gradient, and in general points to stormy conditions and high winds.

Although this method of computing the gradients answers our present purpose, it is open to certain objections. It gives a genuine measure of atmospheric activity, but does not indicate exactly the intensity of air flow. What is needed is some means of measuring "turbulence," that is, both the intensity and area of atmospheric movements, but as yet no such means has been devised. In addition to this general defect pertaining to the whole science of meteorology, there are minor objections pertaining to this particular method. For instance, an isobar may waver back and forth so that it crosses the same parallel repeatedly. To balance this, however, other isobars repeatedly approach the lines of the degree net, but do not cross them. Actual study of the maps shows that neither of these conditions introduces any appreciable error. The isobars that avoid the parallels are obliged to cross the meridians with greater frequency, and vice versa. Moreover, in an area so large as that included in the maps of the Atlantic Ocean—more than 12,000,000 square miles—the isobars are sure to run in all directions. When several days are averaged together, any possible error from this source becomes negligible.

A more important objection arises from the fact that the meridians converge northward. Suppose two storms with identical barometric gradients should center in latitudes 43° and 57° respectively. The number of intersections would be in the ratio of 130 to 155, a difference of 16 per cent. In future investigations it will undoubtedly be better to use a net formed of equidistant lines instead of the degree net. This was not done in the present case simply because it was impossible to undertake so much extra work. Fortunately the use of the simpler method does not alter our results except to make them less distinct. For our present purpose the most important consideration is the change in gradients from one day to the next. This averages between 16 and 17 per cent of the total gradient, and may rise as high as 80 per cent. The daily movement of the average storm toward the north or south, however, is usually only 2° or 3° and rarely exceeds 5°. In so short a distance the change in gradients due to the convergence of the meridians amounts to less than one-fifth of the average change due to other causes. It may mask the other changes somewhat, but can not conceal them. In the southern section of the North Atlantic the effect is less than in the northern, for the meridians converge less rapidly. The parallels, of course, remain equally distant in all parts of the map, and hence introduce no error in the number of intersections.

Under certain circumstances still another source of error may affect the index figures for barometric gradients. In some parts of the maps the isobars are not carried to the margin. Hence, in order that the area under consideration may be the same at all times it becomes necessary either to use only part of the map, or to prolong the isobars to the margin. In the first of the comparisons between the earth and the sun which will shortly be presented the first alternative is adopted. Only the area indicated by dots in figure 1 is used, and it is rarely necessary to prolong the isobars.

In later comparisons, however, the map is divided into two sections lying north and south of the curved solid line near the center of figure 1. The advantages of employing the largest possible area are so great that the method of prolonging the isobars has been adopted. In the southern section of the North Atlantic this introduces only a few new intersections. As most of these are inevitable if the isobars are prolonged in reasonable fashion, they can scarcely introduce an appreciable error. In the northern section the case is different. In order that many storms may be reckoned at their true importance it has seemed wise to prolong the isobars over the unshaded region extending from Labrador to the coast of Iceland. In this area no barometric observations are available. Hence in prolonging the isobars there is more or less opportunity for choice as to just what courses they shall take. In order to see how great an error might thus be introduced, I took the daily maps for February, 1907, and prolonged the isobars for each map in two ways,

trying to make them as different as possible and yet remain within the bounds of probability. The difference in the average number of intersections between isobars and degree net by the two methods amounted to 8 per cent of the gradient index for the northern section of the North Atlantic. This figure, it must be remembered, was obtained only by purposely making the isobars as erratic as could consistently be done. In ordinary cases where extremes are avoided, the probable error is not half so great. Nevertheless, for this reason, as well as for others, small errors occur constantly. Hence, although our index figures are the best at present available, they do not pretend to be more than approximations.

In spite of minor errors the index figures give a reliable picture of the general course of barometric changes from day to day. Within a week's time the gradients frequently swing from 30 or 40 per cent below the normal to an equal distance above it. If all the possible errors should reach a maximum at the same time, and should all produce an apparent swing in one direction, they could not cause a difference half as great as this. As a matter of fact, the various kinds of errors almost never reach a maximum at the same time, or combine in one direction. On the contrary, their constant tendency is to neutralize one another. This is especially the case where large numbers of days are averaged together. This point deserves emphasis. The very fact that our figures for barometric gradients are less exact than for the areas of sunspots makes it doubly significant that we find such strong evidences of a relationship. The errors in the index figures for gradients are not related to solar changes, for they are due to purely terrestrial and human causes. Therefore they fall indiscriminately at any phase of solar activity, and tend to conceal whatever relation may exist between changes in the weather and changes in the sun. If it were possible to obtain absolutely correct figures for the terrestrial gradients, the solar relationships which we shall shortly point out would probably appear even more marked than at present.

Method of computing solar changes.—If the weather is influenced by the sun, changes in the sun's atmosphere are presumably the solar phenomena chiefly concerned. Sunspots are the most obvious and easily measured evidence of the disturbed state of the solar atmosphere. They have been measured with great exactness every day for many years. The data are found in the tables of daily measurements of solar photographs published by the Greenwich Observatory. Most spots consist of two portions, namely, a dark central umbra and a lighter penumbra. The umbral areas average about one-sixth as large as the whole areas.[2] Therefore, in order to work with smaller numbers, the corrected umbral areas are used for the years 1904–1909 when sunspots were abundant, while for the years 1910–1913 when spots were few, the whole areas have been employed. When it is necessary to obtain the combined results for the two sets of years, the figures for whole areas are divided by 6.

One of the essential points of the present investigation is the division of the sun's visible surface into central and marginal portions. Figure 3 shows the sun's disk divided into three equal sections each with a width of 60°. The central section includes the part of the sun within 30° of the central meridian. In the diagram it appears much wider than the others, but this is due merely to foreshortening. So far as is yet evident after numerous trials, the strongest evidence of a relationship

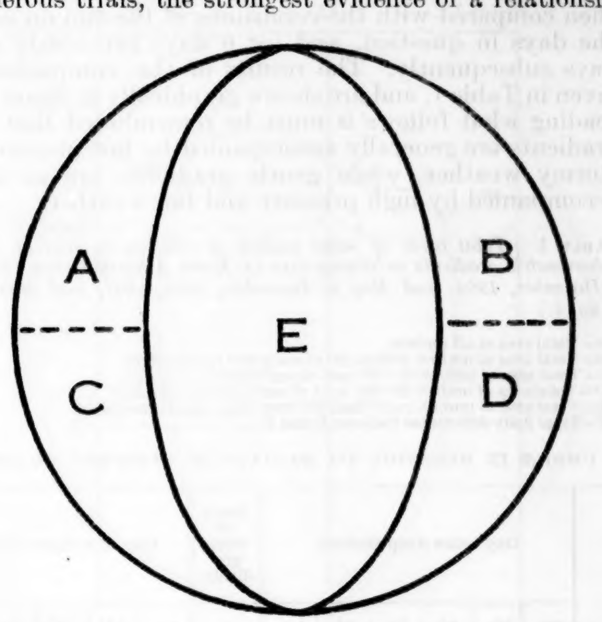

FIGURE 3.—Conventional divisions adopted for the sun's disk.

between the weather and the sun is found when the two outer sections are divided into northern and southern halves while the central section is left undivided.

Comparison between gradients in the stormy section of the North Atlantic Ocean and sunspot areas for 1904, 1906, 1908, and 1909.—In studying the relation of cause and effect the normal order is to begin with the cause and see how its extremes or variations are related to the supposed results. In the present case the opposite method is advisable. From a familiar result we are reaching out to find an unknown cause. Hence we begin with the results and inquire what solar conditions prevailed before and after the times when the terrestrial phenomena were at one extreme or the other. One of the final steps in this process will illustrate the successive approximations by which our ultimate results have been obtained. The terrestrial data are based on the stormy portion of the North Atlantic and of the neighboring continents, that is, on the area marked by dots in figure 1. They cover the months of March to December, 1904, and May to December during the three years 1906, 1908, and 1909. The selection of these dates is purely accidental, being determined by considerations unconnected with the present investigation.

After the daily index figures for gradients had been obtained by the method described above, the approximate normal gradient for each day from March to December was calculated.[3] These normals are more than 50 per cent greater in winter than in summer. In order to eliminate this seasonal effect the index figures have been reduced to percentages of the normal. Thus a severe summer storm appears as important as a severe winter storm provided its gradients rise in equal proportion above the normal. Having reduced the gradients to percentages, it was easy to select from each year the days having either

[2] The ratios for the two years 1907 and 1908 when sunspots were numerous are 6.6 and 6.4. For years when sun spots were few they are: 1910, 5.3; 1911, 5.5; 1912, 5.3; 1913, 9.4. Average for these six years, 6.4.

[3] In the preliminary investigation here under discussion the normals are only approximations based on the monthly averages for the 4 years. These averages are smoothed by the equation $b=\frac{a+2b+c}{4}$ and the results are counted as the normals for the 15th day of the month. The values for the other days are obtained by interpolation. In the main investigation with which this series of papers is chiefly concerned, the daily normals are based on the smoothed monthly averages for 10 years, and are obtained by interpolation as described above.

the steepest or the gentlest gradients, approximately 50 of each for each year. The 390 days thus selected were then compared with the conditions of the sun on each of the days in question, and for 6 days previously and 5 days subsequently. The results of this comparison are given in Table 1, and are shown graphically in figure 4. In reading what follows it must be remembered that steep gradients are generally accompanied by low pressure and stormy weather, while gentle gradients are as a rule accompanied by high pressure and fair weather.

TABLE 1.—*Total areas of solar umbræ in relation to days of extreme barometric gradients in stormy area of North Atlantic Ocean, March to December, 1904, and May to December, 1906, 1908, and 1909. (See fig. 4.)*

A = Total area of all umbræ.
B = Total area of umbræ within 30° of sun's central meridian.
C = Total area of umbræ 30°–90° east of sun's central meridian.
D = Total area of umbræ 30°–90° west of sun's central meridian.
E = Total area of umbræ more than 30° from sun's central meridian.
F = Total daily differences between C and D.

I. UMBRÆ IN RELATION TO 194 DAYS OF STEEPEST GRADIENTS.

	Day before steep gradient.						Days of steep gradients.	Day after steep gradient.				
	6th.	5th.	4th	3d.	2d.	1st.	0	1st.	2d.	3d.	4th.	5th.
A.....	22,611	23,679	24,029	24,538	24,733	24,374	23,696	23,796	22,837	22,622	23,477	22,432
B.....	9,689	9,379	9,060	8,338	8,165	8,885	9,470	10,902	10,068	10,385	9,833	8,863
C.....	5,681	6,433	6,665	7,402	7,473	7,471	6,790	6,031	5,974	5,252	5,910	5,762
D.....	7,214	7,867	8,304	8,798	9,095	8,019	7,436	6,863	6,795	6,985	7,736	7,807
E.....	12,922	14,300	14,969	16,200	16,568	15,489	14,226	12,894	12,769	12,237	13,646	13,569
F.....	9,988	10,980	11,416	11,688	12,035	10,715	9,570	9,294	8,665	9,190	10,136	9,141

II. UMBRÆ IN RELATION TO 196 DAYS OF GENTLEST GRADIENTS.

	Day before steep gradient.						Days of steep gradients.	Day after steep gradient.				
	6th.	5th.	4th.	3d.	2d.	1st.	0	1st.	2d.	3d.	4th.	5th.
A.....	18,832	19,275	17,560	17,219	17,228	17,207	17,749	17,205	17,629	17,648	17,908	16,979
B.....	5,914	5,542	5,433	5,887	6,863	7,408	7,531	7,197	6,676	6,813	6,758	6,218
C.....	4,839	5,359	4,847	5,123	4,887	4,965	5,318	4,783	4,772	4,749	4,721	4,840
D.....	8,079	8,374	7,280	6,209	5,478	4,834	4,900	5,225	6,181	6,122	6,429	5,911
E.....	12,918	13,733	12,127	11,332	10,365	9,799	10,218	10,008	10,953	10,871	11,150	10,761
F.....	10,238	10,989	9,274	8,226	7,801	7,915	7,492	7,594	8,139	8,471	8,509	7,835

This table presents several remarkable features which can best be appreciated by a study of figure 4. The lines are there arranged in pairs, the solid line of each pair representing solar conditions in respect to steep gradients, and the dotted line in respect to gentle gradients. In the upper pair, A represents the total area of sunspots on all parts of the sun's visible surface for 6 days before and 5 days after 194 days of unusually steep gradients, while A′ represents the same thing for 196 days of unusually gentle gradients. During the years in question the spottedness of the sun was evidently much greater when the gradients were steep than when they were gentle. The maximum difference comes two days before what appear to be the terrestrial responses.

Further analysis, as appears in E and B, discloses the important fact that the sun's central and marginal portions appear to have an inverse relationship to the earth's atmosphere. Contrast the solid lines E and B. The line E, which represents the spottedness of the sun's margins, rises sharply from the sixth to the second day before the occurrence of steep gradients. The line B, on the other hand, which represents the spottedness of the central part of the sun, shows an almost equally marked decline until the same day. On that day the difference between the center and the margin rises to over 100 per cent, while during the five days after the time of steep gradients it averages only 40 per cent. The contrast between the two dotted lines, B′ and E′, is as marked as between the solid lines, but it is reversed. Days of gentle barometric gradients come after times of relatively few spots in the marginal portions of the sun and after days of many spots in the center. It is worth noting that the two solid lines reach their extreme points two days before the related barometric conditions, while with the dotted lines the interval is only one day or less. This seems to suggest that the conditions which flatten the barometric gradients act more quickly than those which steepen them.

Comparison between the sun's eastern and western margins.

Having seen that during the four years in question the sun's margins, rather than its central portion, appear to have been effective in causing barometric disturbances, we are naturally led to inquire whether there is any difference between the influence of the east and west margins. The answer to this question is inconclusive. The solid lines C for the east margin and D for the west in figure 4 show substantially the same sort of maximum one or two days before the time of steep gradients. This suggests that so far as storms are concerned the influence of the two margins is similar. The dotted line C′, however, suggests that quiet barometric conditions bear no perceptible relation to the eastern margin, for it remains constantly near one level. A diminution of spots on the western margin, however, as appears from D′, seems to occur in connection with gentle gradients, just as does an increase in connection with steep gradients.

Another fact also suggests that the western margin is more important than the eastern. The average height of the western lines, D and D′, is decidedly greater than that of the eastern lines, C and C′, and is nearly equal to that of the central lines, B and B′. To put the matter more concretely, on the second day before times of unusually steep gradients the sunspots in the three sections of the sun stand in the ratios indicated by the upper line of Table 2. If terrestrial storms had no relation to the sun's changes, and hence if these figures were arranged merely by chance, the ratios ought to be approximately as in line III. This shows the percentage of spots visible in each of the three sections of the sun during the entire period from 1904–1913. It is typical of the average amount of spottedness in each section of the sun's surface when long periods are considered. The average distribution of the visible spots may be expressed in another way, thus: The proportion of spots is 40 per cent within 30° of the central meridian, $36\frac{1}{2}$ per cent within 30–60° from the central meridian, and $23\frac{1}{2}$ per cent in the area more than 60° from the center. This diminution in the area of visible spots as one proceeds from the sun's center outward is due largely to the way in which the sun's margins are turned away from the earth.

TABLE 2.—*Ratios of sunspots on various parts of the sun's surface.*

	Within 60° of sun's eastern margin.	Central 60° of sun's disk.	Within 60° of sun's western margin.
	Per cent.	*Per cent.*	*Per cent.*
I. Second day before times of unusually steep gradients	30	33	37
II. First day before times of unusually gentle gradients	29	43	28
III. Average conditions without regard to storminess, 1904–1913	30	40	30
IV. Ratio of (I) to expectation	1.00	0.82	1.23
V. Ratio of (II) to expectation	0.97	1.07	0.93

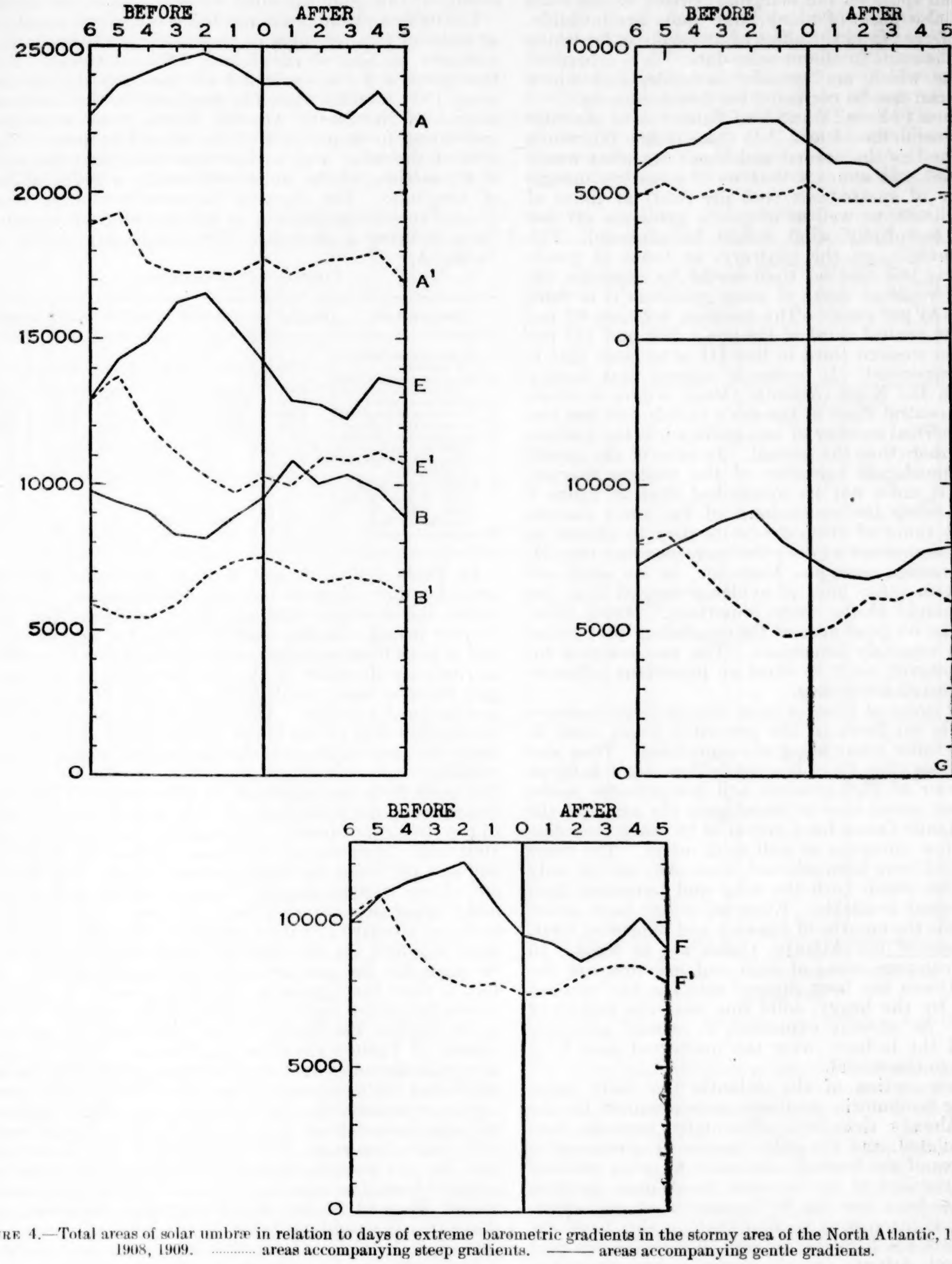

FIGURE 4.—Total areas of solar umbræ in relation to days of extreme barometric gradients in the stormy area of the North Atlantic, 1904, 1906, 1908, 1909. .... areas accompanying steep gradients. ——— areas accompanying gentle gradients.

Owing to the oblique angle at which they are viewed many small spots on the marginal portion of the sun's disk and also parts of many large spots are invisible. This is different from the effect of perspective, for which allowance is made in all our solar data. It is concerned with areas which are actually invisible, and which therefore can not be corrected for foreshortening.

The figures in lines IV and V of Table 2 show the ratio of the figures in lines I and II to those in line III, which are reckoned as the normal and hence are what would be expected. It appears that on the eastern margin the degree of spottedness (100 per cent) at times of steep gradients, as well as of gentle gradients (97 per cent), is essentially what would be expected. The western margin, on the contrary, at times of gentle gradients is less spotted than would be expected (93 per cent), while at times of steep gradients it is more spotted (123 per cent). The contrast between 82 per cent in the central third of the sun's disk and 123 per cent in the western third in line III is so large that it may be important. It seems to suggest that stormy weather in the North Atlantic Ocean occurs at times when the central third of the sun's visible disk has less than the normal number of sun spots while the western third has more than the normal. In spite of the apparently preponderant influence of the western margin, however, it must not be overlooked that in figure 4 line C showing the spottedness of the sun's eastern margin at times of steep gradients rises to almost as marked a maximum as does the corresponding line, D, for the western margin. Moreover, as we shall see later, certain other lines of evidence suggest that the eastern margin is the more important. Hence there seems to be no good ground for concluding that either margin is especialy important. The two margins together, however, seem to exert an important influence upon terrestrial storminess.

Sunspot areas at times of great changes in gradients.—The results set forth in the preceding pages seem to warrant a fuller study along the same lines. They also seem to show that there is a marked contrast between the behavior of high-pressure and low-pressure areas. It therefore seems wise to investigate the whole of the North Atlantic Ocean for a period of 10 years, including times of few sunspots as well as of many. The years 1904 to 1913 have been selected, since they are the only 10 years for which both the solar and terrestrial data are at present available. Even so, it has been necessary to omit the months of January and February, 1904, as no maps of the Atlantic Ocean are at hand. In order to compare areas of high and low pressure the Atlantic Ocean has been divided into the two sections indicated by the heavy, solid line near the middle of figure 1. As already explained, it seemed advisable to extend the isobars over the uncharted area from Labrador to Greenland.

For each section of the Atlantic the daily index figures for barometric gradients were obtained by the method already described. The daily normals were then calculated, and the index figures were reduced to percentages of the normal. In order to get a measure of the variability of the weather the changes in these percentages from one day to the next were also calculated. It is interesting to find that on this basis the variability of the high-presure area in the southern part of the North Atlantic Ocean appears greater than that of the low-pressure area farther north. Of course the actual change from day to day in the stormy low-pressure area is much greater than in the other, but by reason of the gentleness of the gradients the *percentage* of change in the south exceeds that in the north.

Let us first examine the condition of the sun's surface at times of great changes in barometric gradients in the northern section of the North Atlantic Ocean. For this purpose I have selected all the days during the years 1904 to 1909 when the gradients in the northern section of the North Atlantic Ocean show a change amounting to 30 per cent of the normal or more. The area of the solar umbrae has been computed for each of six sections of the sun's disk having a width of 30° of longitude. The days of barometric change were divided into those showing an increase of gradients and those showing a decrease. The results are shown in Table 3A.

TABLE 3.—*Areas of umbræ.*

Solar longitude.	60–90° W.	30–60° W.	0–30° W.	0–30° E.	30–60° E.	60–90° E.
A. 148 days of great increase of gradients	2,775	3,246	3,752	3,901	4,636	2,362
B. 144 days of great decrease of gradients	2,411	3,695	3,773	3,662	3,730	1,997
C. Umbral areas 1904–1913	34,680	53,507	57,930	57,757	52,250	33,729
D A corrected on basis of C	4,720	3,560	3,752	3,901	5,080	4,030
E. B corrected on basis of C	4,120	4,070	3,773	3,662	4,110	3,400
F. D expressed in percentages of the average area within 30° of central meridian	123	93	98	102	133	105
G. E expressed in percentages of the average area within 30° of central meridian	111	110	102	98	111	92
H. Average of F and G	117	101	100	100	122	99

In Table 3 lines A and B show the actual umbral areas for days of great increase and decrease. Line C shows the average distribution of sunspots for the 10-year period. In the next two lines the figures of A and B have been corrected on the basis of line C in order to eliminate the effect of the foreshortening of the margins whereby many small spots and parts of large spots are rendered invisible. The correction is based on the assumption that in line C the figures would all be essentially the same as those in the two central sections if the visibility were everywhere the same. In lines F and G the same facts are expressed in percentages. The last line sums up the whole matter. On days of great change in the strength of barometric gradients during the period 1904–1909 there was an excess of spottedness between 30° and 60° from the sun's eastern margin and within 30° of the western margin. Since a certain amount of delay apparently occurs between the time when the sunspots are effective and the time when their effect becomes most manifest on the weather maps allowance should be made for the sun's rotation during this period. If this is done the figures in the table should be shoved somewhat to the right. In other words, because of the sun's rotation the figures in the righthand or eastern column of Table 3 are of no significance. They pertain to conditions a day or two after those which seem to be associated with barometric changes. Hence their average is approximately 100 (actually 99). This explains why the sun's western margin appeared on a former page to be more important than the eastern. As a matter of fact the two margins appear to be essentially equal as appears from the numbers 117 and 122 in longitudes 60–90° W. and 30–60° E. When these numbers are shoved to the right in Table 3, and when allowance is thus made for the sun's rotation, it appears that changes in barometric gradients in the North Atlantic Ocean are associated with an abundance of sunspots approximately 10° to 40° from either margin of the sun's disk. The solar relationship of an increase in barometric gradients

seems to be stronger than that of a decrease as appears from a comparison of line F, having values of 123 and 133, with line G where the corresponding values are both 111. This, however, is of minor importance compared with the outstanding fact that both margins of the sun apparently have a genuine connection with changes of barometric gradients in the Atlantic Ocean.

Comparison of North Atlantic low-pressure and high-pressure areas with solar quadrant differences, 1904–1913.—It is important that our results should be tested in many different ways. Therefore let us employ still another the greatest increase in gradients also fall among the 500 having the highest gradients.

In dealing with the solar data we shall this time employ a method which takes account of only the marginal parts of the sun, at a distance of more than 30° from the central meridian. Each marginal section is divided into a northern and a southern half by means of the solar equator. Thus on the outer borders of the four solar quadrants formed by the central meridian and the equator we have the four areas marked A, B, C, and D in figure 3. In accordance with indications which grew

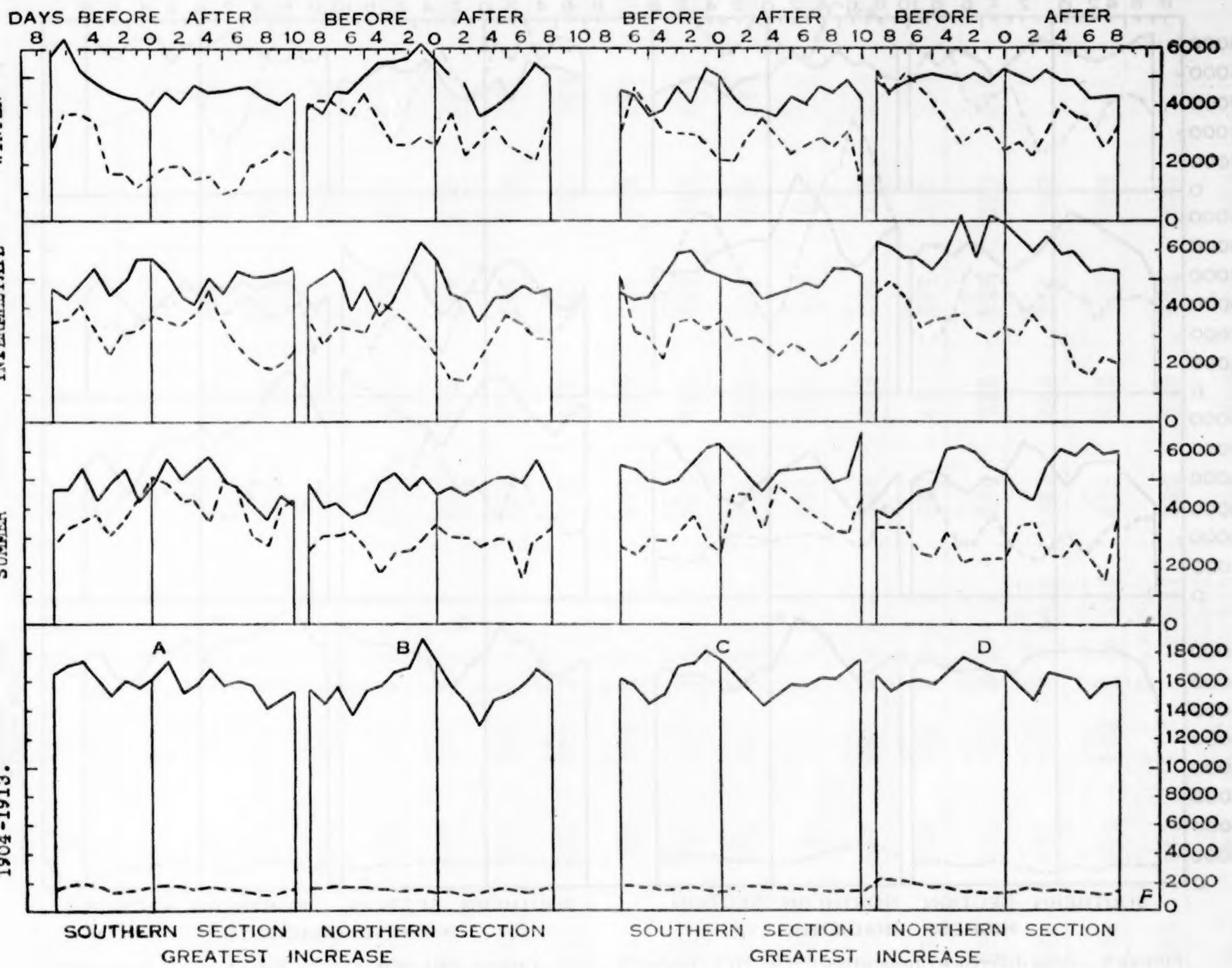

FIGURE 5.—Solar differences (unsmoothed) NW.+SE. compared with NE.+SW. (Cf. Table 3). ——— Umbræ, 1904–1909. .... Total area, 1910–1913.

method of comparing the sun with the following four types of barometric conditions: (1) The days with *highest* gradients, (2) the days with *lowest* gradients, (3) the days with *greatest increase* in the strength of the gradients, and (4) the days with *greatest decrease*. For each of the 10 years the 50 most extreme days of each kind were selected. In some cases the days of highest gradients and of greatest increase are the same, just as are the days of lowest gradients and of greatest decrease. This is by no means the rule, however, for often a sudden increase or decrease is followed by several relatively uniform days with unusually high or low gradients as the case may be. For example, in the northern section of the North Atlantic only 211 of the 500 days having more and more distinct as one method after another was tried, the sum of the spots in the outer parts of the diametrically opposed quadrants A and D is compared with the sum of the similar pair B and C. It is immaterial which of the two sums is larger. Their difference seems to form an approximate measure of the sun's effect in causing barometric changes from day to day. It may be termed the difference between the marginal portions of the diametrically united pairs of quadrants. For the sake of brevity, however, and in lieu of some better term, it will hereafter be referred to as the "diametric quadrant difference," or simply the "quadrant difference."

Table 4 and figures 5 and 6 give some of the results obtained by this method. In the diagrams the solid

lines show the areas of solar *umbræ* during the 6 years from *1904 to 1909*. These years were characterized by abundant sunspots. The dotted lines indicate *total areas* of sunspots from 1910–1913.[4] In examining figures 5 and 6, it must be remembered that most of the dotted lines are about 6 times as high as they would be if umbræ were used for the years 1910 to 1913 as well as for 1904 to 1909. Only at the bottom of the diagrams have the dotted lines been reduced to a scale commensurate with that of the solid lines.

each diagram, and the other the inner pair. All four of the outer curves, that is, A, D, E, and H, may be described as rising to a maximum not far from the left-hand end, and then gradually declining toward the right. To this extent they may be called similar, but the similarity is so vague that it would be rash to draw conclusions from it. Hence it appears that high gradients and great increase in the southern section of the North Atlantic and low gradients and great decrease in the northern section do not give much evidence of any

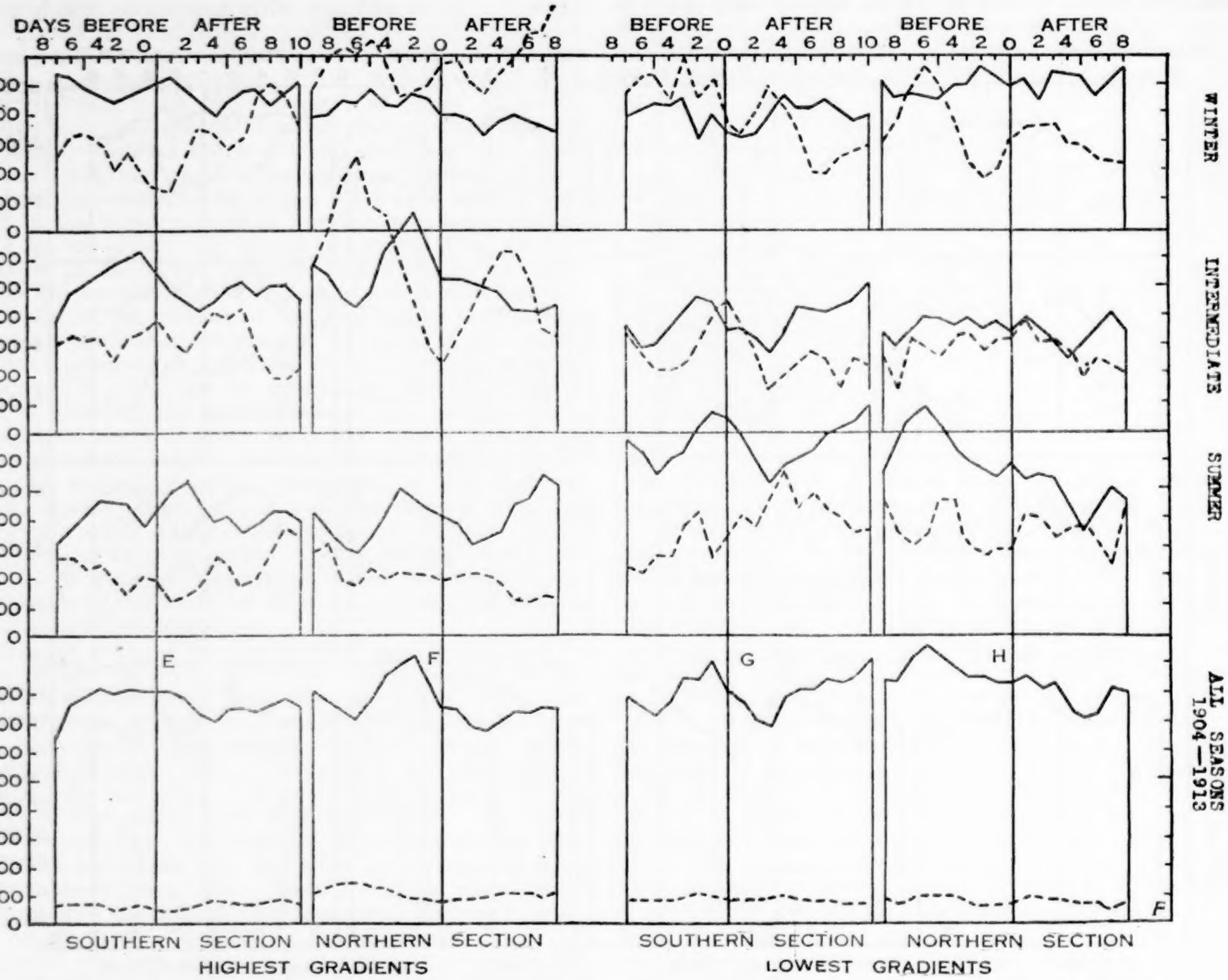

FIGURE 6.—Solar difference (unsmoothed), NW. (Cf. Table 3.) ——— Umbræ, 1904–1909. ········· Total sunspots, 1910–1913.

In each vertical series of curves in figures 5 and 6 the upper three pairs represent the solar conditions during (1) the winter from December to March, (2) the intermediate season, including April and May in the spring and October and November in the autumn, and (3) the summer from June to September. The lowest pair of curves, below the heavy lines, represent the entire year.

If attention be limited to the heavy, solid lines at the bottom of figures 5 and 6, they will be seen to fall into two groups. One comprises the outer pair of lines in

[4] The smoothed relative sunspot numbers from 1904 to 1913 are as follows, according to Wolfer: 1904, 44.1; 1905, 58.7; 1906, 60.3; 1907, 56.0; 1908, 51.2; 1909, 40.6; 1910, 21.0; 1911, 6.5; 1912, 3.4; 1913, 2.2.

clear-cut solar relationship. It must be remembered, however, that in a previous comparison where the most stormy parts of both the northern and southern sections of the North Atlantic were considered, and where we dealt only with years of abundant sunspots, we found a solar relationship in connection with both high and low gradients. In figures 5 and 6 the other four lower curves, B, C, F, and G, display considerable similarity. Each descends slightly on the left, and then rises to a sharply defined maximum one or two days before the day marked zero, which serves as the point of reference. The maximum is followed by a steep and regular drop until the third day after the day of reference. Then comes a more or less pronounced ascent.

TABLE 4.—*Daily differences between disturbances of sun's surface in NW.+SE. quadrants and in NE.+SW. quadrants.*

For the years 1904-1909 the figures denote the areas of solar umbræ, while for 1910-1913 they denote total areas of sunspots and should be divided by 6 to make them commensurable with the umbral areas. In all cases only the part of the sun more than 30° from the central meridian is considered. *See Figures 5, 6, and 7.*

IN RELATION TO DAYS OF GREATEST INCREASE IN SOUTHERN SECTION OF NORTH ATLANTIC OCEAN.

[Summary H 1-6.] [1]

	Cases.	Days before.							Day of greatest increase.	Days after.									
		7	6	5	4	3	2	1		1	2	3	4	5	6	7	8	9	10
1904:																			
Winter	9	251	506	252	410	268	232	884	305	296	337	241	355	423	325	...	...	...	...
Intermediate	20	594	521	378	631	501	734	741	531	559	439	455	779	804	832	...	...	...	...
Summer	21	471	418	489	685	249	784	568	430	368	443	495	535	451	395	...	...	...	...
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1905:																			
Winter	19	2,156	2,691	2,106	1,686	1,579	1,704	1,202	976	1,423	1,194	1,882	1,759	1,678	1,537	...	...	...	...
Intermediate	19	922	774	963	1,305	1,097	1,061	1,599	2,087	1,391	1,094	950	1,338	1,140	1,299	...	...	...	...
Summer	12	912	1,295	1,151	840	1,070	589	531	943	994	813	1,032	1,029	1,089	1,052	...	...	...	...
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1906:																			
Winter	18	658	705	810	794	673	799	826	639	804	693	692	559	543	784	723	807	478	779
Intermediate	14	377	372	430	505	475	428	376	259	386	506	537	587	558	435	490	362	490	350
Summer	18	795	613	802	740	602	673	733	646	795	527	640	596	627	626	352	777	817	692
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1907:																			
Winter	11	1,085	1,102	833	665	1,020	722	755	794	800	569	856	737	637	747	592	619	904	884
Intermediate	16	1,153	1,166	1,380	1,378	1,124	1,172	1,354	1,382	1,276	752	513	780	894	1,076	959	1,193	1,057	1,112
Summer	23	1,147	1,165	1,853	1,690	1,351	1,627	970	1,357	1,632	1,766	2,060	2,304	1,611	1,401	1,085	735	1,334	924
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1908:																			
Winter	18	784	780	673	778	319	413	552	438	526	592	571	622	775	638	615	606	491	535
Intermediate	18	486	525	539	521	584	476	493	485	499	647	696	715	484	604	302	343	376	784
Summer	14	504	279	384	546	633	495	393	324	510	497	411	532	506	667	659	423	418	355
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1909:																			
Winter	14	836	619	603	532	705	500	588	675	731	529	509	435	510	627	797	471	403	402
Intermediate	17	1,127	966	1,210	1,078	682	1,004	1,154	981	1,189	988	938	822	581	1,021	1,204	1,073	1,109	879
Summer	19	877	897	752	788	955	1,232	1,077	1,205	1,508	1,017	803	856	887	640	708	629	475	871
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1904-1909:																			
Winter	89	5,770	6,403	5,277	4,865	4,564	4,370	4,207	3,827	4,580	4,134	4,751	4,482	4,566	4,658	(4,562) 2,727	(4,288) 2,503	(4,020) 2,276	*(4,450) 2,600
Intermediate	104	4,659	4,324	4,900	5,416	4,463	4,875	5,717	5,725	5,300	4,426	4,089	5,021	4,461	5,267	(5,070) 2,955	(5,120) 2,971	(5,220) 3,032	(5,400) 3,125
Summer	107	4,706	4,667	5,431	4,289	4,866	5,400	4,272	4,905	5,807	5,063	5,441	5,852	5,171	4,781	(4,114) 2,804	(3,686) 2,564	(4,486) 3,044	(4,065) 2,842
Total	**300**	**15,135**	**15,394**	**15,608**	**14,570**	**13,893**	**14,645**	**14,196**	**14,457**	**15,687**	**13,623**	**14,281**	**15,355**	**14,198**	**14,706**	**13,746**	**13,094**	**13,726**	**13,915**
1910:																			
Winter	14	2,012	2,697	2,771	2,385	984	1,113	793	966	1,209	1,361	1,169	1,385	769	962	1,510	1,329	1,707	1,729
Intermediate	16	1,508	942	1,216	1,215	1,537	2,361	2,282	2,614	2,074	1,405	1,817	2,204	1,368	1,279	637	1,045	957	1,116
Summer	20	1,759	2,371	2,708	2,522	2,253	3,180	3,709	4,714	4,340	3,699	3,570	2,840	4,523	4,017	2,850	2,554	3,358	3,968
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1911:																			
Winter	10	187	208	231	265	194	282	246	262	241	133	27	141	100	55	378	572	569	467
Intermediate	19	1,095	1,044	1,161	931	591	655	821	965	1,329	1,351	913	1,216	872	903	924	559	895	1,346
Summer	21	656	757	614	969	606	398	473	197	270	286	339	471	266	475	144	42	59	30
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1912:																			
Winter	16	270	612	635	773	449	136	34	0	318	360	249	70	47	0	43	68	138	62
Intermediate	15	843	1,599	1,625	1,009	247	72	25	12	112	563	910	1,235	1,189	451	613	267	110	83
Summer	19	278	235	221	304	297	13	190	235	330	262	381	214	240	212	78	55	474	393
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1913:																			
Winter	15	113	248	138	30	62	133	190	232	121	66	17	0	70	135	47	103	22	62
Intermediate	15	70	0	0	44	12	44	72	97	0	60	97	0	0	0	0	0	0	0
Summer	20	0	6	0	0	0	32	45	31	32	45	31	0	0	0	0	0	0	6
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1910-1913:																			
Winter	55	2,582	3,765	3,780	3,453	1,689	1,664	1,263	1,460	1,889	1,920	1,462	1,596	986	1,152	1,978	2,072	2,436	2,320
Intermediate	65	3,516	3,585	4,020	3,199	2,387	3,132	3,200	3,688	3,515	3,379	3,737	4,655	3,429	2,633	2,174	1,871	1,962	2,545
Summer	80	2,693	3,369	3,548	3,795	3,156	3,623	4,417	5,177	4,972	4,292	4,321	3,525	5,029	4,704	3,072	2,651	3,891	4,397
Total	**200**	**8,791**	**10,719**	**11,343**	**10,447**	**7,232**	**8,419**	**8,880**	**10,325**	**10,376**	**9,591**	**9,520**	**9,776**	**9,444**	**8,489**	**7,224**	**6,594**	**8,289**	**9,262**
Grand total 1904-13:																			
Winter	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Intermediate	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Summer	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	...	**16,603**	**17,184**	**17,498**	**16,310**	**15,123**	**16,065**	**15,664**	**16,177**	**17,417**	**15,223**	**15,869**	**16,985**	**15,773**	**16,104**	**15,950**	**14,194**	**15,106**	**15,459**

* The numbers in parentheses make allowance for the numbers missing in 1904 and 1905.

TABLE 4.—*Daily differences between disturbances of sun's surface in NW.+SE. quadrants and in NE.+SW. quadrants*—Continued.

For the years 1904–1909 the figures denote the areas of solar umbræ, while for 1910–1913 they denote total areas of sunspots and should be divided by 6 to make them commensurable with the umbral areas. In all cases only the part of the sun more than 30° from the central meridian is considered. *See Figures 5, 6, and 7.*

IN RELATION TO DAYS OF GREATEST INCREASE IN NORTHERN SECTION OF NORTH ATLANTIC OCEAN.

[Summary H 1–6.][1]

	Cases.	Days before.									Day of greatest increase.	Days after.									
		9	8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8	9	10
1904:																					
Winter	9	284	397	406	368	457	509	429	336	490	326	411	375	303	395	241	282	259	291	......	......
Intermediate	22	633	716	735	657	645	705	838	507	721	496	479	363	419	590	670	614	628	847	......	......
Summer	19	369	346	415	427	482	471	455	452	419	445	362	353	303	521	670	525	430	324	......	......
Total	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1905:																					
Winter	16	1,180	1,032	1,099	866	1,167	1,629	1,471	1,328	1,587	1,205	1,435	1,191	814	732	881	1,179	1,482	963	......	......
Intermediate	15	664	650	811	866	1,500	971	994	1,271	1,013	1,417	630	796	791	962	597	870	1,152	1,038	......	......
Summer	19	1,378	1,218	1,107	1,104	810	933	1,268	1,075	1,096	1,351	1,456	1,567	1,513	913	962	732	749	1,116	......	......
Total	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1906:																					
Winter	17	475	488	787	896	837	704	752	669	903	959	1,021	803	542	616	729	615	625	773	......	......
Intermediate	17	413	533	575	534	476	588	516	643	605	550	488	552	444	537	544	710	775	705	......	......
Summer	16	836	648	623	574	631	779	741	728	1,087	639	697	769	898	982	891	839	705	591	......	......
Total	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1907:																					
Winter	18	949	740	1,047	906	1,200	1,442	1,299	1,863	1,805	1,498	1,160	1,389	1,078	903	1,049	1,291	1,544	2,046	......	......
Intermediate	15	1,508	1,573	1,086	360	538	478	759	1,414	2,144	1,941	1,617	1,035	863	1,172	1,449	1,246	862	698	......	......
Summer	17	1,210	841	959	631	609	1,169	1,606	1,429	1,483	1,023	860	740	835	1,014	850	870	1,004	894	......	......
Total	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1908:																					
Winter	19	457	549	534	669	694	547	708	614	410	545	434	526	415	649	692	718	936	727	......	......
Intermediate	14	681	821	896	466	594	358	455	680	765	586	570	850	363	514	357	597	364	617	......	......
Summer	17	835	614	597	418	748	1,059	693	470	580	525	735	570	672	632	605	926	1,543	1,216	......	......
Total	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1909:																					
Winter	14	735	593	660	764	686	687	865	788	920	819	561	527	503	589	682	693	578	280	......	......
Intermediate	15	847	795	1,163	962	966	684	735	811	1,031	732	645	698	607	573	709	703	774	705	......	......
Summer	21	272	402	485	569	682	544	520	455	518	549	724	494	471	942	1,063	1,080	1,313	565	......	......
Total	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1904–1909:																					
Winter	93	4,080	3,799	4,533	4,469	5,041	5,518	5,574	5,668	6,115	5,552	5,022	4,811	3,655	3,884	4,224	4,778	5,424	5,080	......	......
Intermediate	98	4,746	5,088	5,266	3,845	4,719	3,784	4,297	5,326	6,278	5,722	4,436	4,294	3,487	4,348	4,326	4,740	4,555	4,610	......	......
Summer	109	4,900	4,069	4,186	3,713	3,962	4,955	5,283	4,609	5,181	4,532	4,734	4,493	4,692	5,004	5,041	4,972	5,744	4,706	......	......
Total	**300**	**13,726**	**12,956**	**13,985**	**12,027**	**13,722**	**14,257**	**15,154**	**15,603**	**17,574**	**15,806**	**14,192**	**13,598**	**11,834**	**13,236**	**13,591**	**14,490**	**15,723**	**14,396**	......	......
1910:																					
Winter	17	2,822	2,908	2,893	2,349	2,808	1,979	1,324	1,456	2,164	1,941	3,047	1,641	1,783	2,237	1,890	1,968	1,653	2,797	......	......
Intermediate	14	1,482	1,431	1,890	2,066	2,045	3,142	3,116	2,332	2,001	1,121	378	292	497	1,151	1,499	1,626	1,455	1,030	......	......
Summer	19	1,913	2,176	1,908	2,353	2,104	1,389	1,862	2,053	2,298	2,734	2,112	2,052	1,764	2,087	2,513	1,399	2,582	2,964	......	......
Total	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1911:																					
Winter	16	551	485	511	607	519	248	336	358	360	428	382	428	429	382	126	113	61	283	......	......
Intermediate	23	1,087	984	1,145	1,089	1,061	944	787	919	704	823	886	901	993	1,343	1,502	1,314	937	775	......	......
Summer	11	419	433	290	216	226	195	525	381	378	395	294	171	214	116	37	0	23	304	......	......
Total	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1912:																					
Winter	15	362	584	533	468	786	1,141	979	720	269	90	212	251	541	588	457	222	330	386	......	......
Intermediate	17	1,039	228	193	26	18	5	8	118	131	187	95	28	510	562	624	467	425	905	......	......
Summer	18	240	402	797	591	384	223	133	60	256	343	699	790	717	727	400	210	248	56	......	......
Total	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1913:																					
Winter	19	225	223	191	284	278	185	45	99	175	150	74	34	32	80	154	38	109	121	......	......
Intermediate	17	0	87	55	70	0	44	12	87	115	167	147	239	125	130	97	0	60	97	......	......
Summer	14	0	0	32	45	31	6	0	0	0	0	0	0	32	45	31	0	0	0	......	......
Total	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1910–1913:																					
Winter	67	3,960	4,200	4,148	3,658	4,391	3,553	2,684	2,633	2,968	2,609	3,715	2,354	2,785	3,287	2,627	2,341	2,153	3,587	......	......
Intermediate	71	3,608	2,730	3,283	3,251	3,124	4,135	3,923	3,456	2,951	2,298	1,506	1,460	2,125	3,186	3,722	3,407	2,877	2,807	......	......
Summer	62	2,542	3,011	3,027	3,205	2,745	1,813	2,520	2,494	2,932	3,472	3,105	3,013	2,727	2,985	2,981	1,609	2,853	3,324	......	......
		(1,685)	(1,657)	(1,743)	(1,686)	(1,710)	(1,584)	(1,521)	(1,431)	(1,475)	(1,397)	(1,388)	(1,138)	(1,273)	(1,576)	(1,555)	(1,226)	(1,314)	(1,620)		
Total	**200**	**10,110**	**9,941**	**10,458**	**10,114**	**10,260**	**9,501**	**9,127**	**8,583**	**8,851**	**8,379**	**8,326**	**6,827**	**7,637**	**9,458**	**9,330**	**7,357**	**7,883**	**9,718**	......	......
Grand total 1904–1913:																					
Winter	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Intermediate	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Summer	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Total	......	**15,411**	**14,613**	**15,728**	**13,713**	**15,432**	**15,841**	**16,675**	**17,034**	**19,049**	**17,203**	**15,580**	**14,736**	**13,107**	**14,812**	**15,146**	**15,716**	**17,037**	**16,016**	......	......
Winter	......	**8,831**	**10,108**	**18,304**	**19,449**	**20,188**	**16,925**	**16,265**	**15,703**	**15,752**	**14,134**	**15,038**	**14,264**	**16,012**	**15,676**	**14,251**	**13,770**	**13,729**	**16,943**	**5,919**	**4,138**
Intermediate	......	**9,389**	**9,613**	**20,388**	**18,686**	**15,878**	**15,862**	**15,157**	**14,246**	**13,038**	**12,503**	**10,678**	**11,016**	**11,641**	**13,708**	**15,072**	**14,213**	**11,164**	**9,304**	**5,509**	**5,302**
Summer	......	**5,411**	**6,135**	**9,886**	**9,426**	**10,749**	**9,331**	**11,500**	**12,426**	**10,499**	**11,068**	**13,719**	**13,331**	**12,885**	**15,518**	**13,078**	**11,517**	**13,203**	**11,906**	**6,748**	**8,007**
Whole year	......	23,631	25,856	48,578	47,561	46,815	42,118	42,922	42,375	39,289	37,705	39,435	38,611	40,538	44,902	42,401	39,500	38,096	38,153	18,176	17,447

TABLE 4.—*Daily differences between disturbances of sun's surface in NW.+SE. quadrants and in NE.+SW. quadrants*—Continued.

For the years 1904-1909 the figures denote the areas of solar umbræ, while for 1910-1913 they denote total areas of sunspots and should be divided by 6 to make them commensurable with the umbral areas. In all cases only the part of the sun more than 30° from the central meridian is considered. *See Figures 5, 6, and 7.*

IN RELATION TO DAYS OF GREATEST DECREASE IN SOUTHERN SECTION OF NORTH ATLANTIC OCEAN.

[Summary H 7-12][1]

	Cases.	Days before.							Day of greatest decrease.	Days after.									
		7	6	5	4	3	2	1		1	2	3	4	5	6	7	8	9	10
1904:																			
Winter	6	212	337	274	177	363	374	306	300	327	166	202	119	180	208				
Intermediate	24	640	586	750	719	888	993	633	527	565	681	759	670	736	732				
Summer	20	271	328	496	440	596	536	571	490	486	422	428	533	419	318				
Total																			
1905:																			
Winter	20	1,163	1,200	1,439	1,281	2,089	1,653	2,100	1,800	1,651	1,348	1,309	1,394	1,727	1,194				
Intermediate	15	906	955	648	663	769	1,050	1,053	802	1,014	1,348	1,037	1,295	788	1,333				
Summer	15	983	854	888	916	778	709	775	930	1,134	1,001	568	890	1,207	1,252				
Total																			
1906:																			
Winter	16	900	1,001	585	648	537	416	730	870	607	635	786	703	725	807	828	456	503	790
Intermediate	14	279	323	316	373	909	700	416	499	579	537	439	496	377	284	395	448	778	782
Summer	20	1,001	1,026	713	762	749	931	758	979	772	713	852	1,182	665	754	883	975	561	891
Total																			
1907:																			
Winter	13	793	776	483	763	863	909	1,203	1,198	908	821	666	672	811	1,121	1,199	1,381	1,352	918
Intermediate	13	952	776	1,211	1,637	1,583	1,659	1,227	968	764	445	566	645	713	566	619	503	622	822
Summer	24	1,379	1,625	1,500	1,384	1,675	1,282	1,635	2,109	1,697	1,663	1,653	1,622	1,307	1,301	1,339	1,098	1,315	2,542
Total																			
1908:																			
Winter	13	663	455	272	174	117	198	204	440	465	390	595	235	315	270	356	484	796	698
Intermediate	19	685	654	534	702	546	450	766	924	813	668	774	530	725	632	550	913	948	631
Summer	18	678	943	697	750	513	1,170	1,210	1,105	1,066	814	709	505	1,070	1,113	1,164	848	1,140	1,107
Total																			
1909:																			
Winter	13	840	630	572	778	709	521	772	553	394	460	344	514	578	499	534	545	461	262
Intermediate	19	1,014	983	854	991	1,156	1,099	1,191	1,289	1,226	1,144	753	838	1,263	1,303	971	1,273	1,218	1,080
Summer	18	1,139	584	694	624	697	945	1,117	662	633	451	407	584	668	635	418	519	550	687
Total																			
1904-1909:																			
Winter	81	4,571	4,399	3,625	3,821	4,678	4,071	5,315	5,161	4,352	3,820	3,802	3,637	4,336	4,099	*(4,613) 2,917	(4,518) 2,866	(4,918) 3,112	(4,205) 2,668
Intermediate	104	4,476	4,277	4,313	5,085	5,878	5,951	5,286	5,011	4,961	4,823	4,328	4,474	4,602	4,850	(4,690) 2,863	(5,330) 3,500	(5,350) 3,566	(5,130) 3,315
Summer	115	5,451	5,360	4,988	4,881	5,008	5,564	6,066	6,275	5,789	5,064	4,617	5,316	5,336	5,373	(5,440) 3,804	(4,920) 3,440	(5,100) 3,566	(6,800) 5,227
Total	**300**	**14,498**	**14,036**	**12,926**	**13,787**	**15,564**	**15,586**	**16,667**	**16,447**	**15,102**	**13,707**	**12,747**	**13,427**	**14,274**	**14,322**	**14,743**	**14,768**	**15,368**	**16,135**
1910:																			
Winter	15	2,518	4,063	3,619	2,842	2,532	2,009	1,607	1,324	1,304	2,559	3,480	2,421	1,534	1,787	2,318	2,334	2,826	986
Intermediate	14	1,799	899	1,761	1,438	2,063	2,414	2,070	2,093	1,547	1,460	1,162	1,001	1,138	1,063	817	516	632	1,059
Summer	21	1,922	1,775	1,936	1,933	2,043	2,575	2,102	1,789	3,792	3,808	2,977	4,047	3,630	3,285	3,088	2,419	2,630	3,744
Total																			
1911:																			
Winter	8	236	267	269	110	108	323	366	344	542	395	126	139	236	180	126	94	243	313
Intermediate	20	1,503	1,112	805	531	915	803	828	1,134	1,133	1,337	1,168	803	608	721	916	1,153	1,491	1,412
Summer	22	557	473	784	571	606	677	438	273	244	258	164	346	426	265	356	112	67	229
Total																			
1912:																			
Winter	16	253	136	0	188	354	467	659	463	215	0	77	212	569	638	433	136	0	0
Intermediate	16	1,793	1,020	366	287	504	324	230	236	43	12	469	514	920	703	235	517	636	781
Summer	18	155	129	158	283	375	375	296	379	471	366	228	408	474	331	210	668	453	423
Total																			
1913:																			
Winter	13	131	45	22	35	89	224	112	37	14	18	8	76	40	0	0	44	15	26
Intermediate	13	55	70	0	0	0	60	97	87	99	82	0	0	0	0	0	0	0	0
Summer	24	32	45	63	45	31	0	0	0	6	0	0	0	0	0	0	32	45	31
Total																			
1910-1913:																			
Winter	52	3,138	4,511	3,910	3,175	3,074	3,023	2,744	2,168	2,075	2,972	3,691	2,848	2,379	2,605	2,877	2,608	3,184	1,320
Intermediate	63	5,150	3,101	2,932	2,256	3,482	3,601	3,225	3,550	2,822	2,891	2,799	2,318	2,666	2,487	1,968	2,186	2,759	3,252
Summer	85	2,666	2,422	2,941	2,832	3,053	3,627	2,836	2,441	4,513	4,432	3,369	4,801	4,530	3,881	3,654	3,231	3,195	4,427
Total	**200**	**10,954**	**10,034**	**9,783**	**8,263**	**9,609**	**10,251**	**8,805**	**8,159**	**9,410**	**10,295**	**9,859**	**9,967**	**9,575**	**8,973**	**8,499**	**8,025**	**9,138**	**8,999**
Grand total 1904-13:																			
Winter																			
Intermediate																			
Summer																			
Total		**16,324**	**15,708**	**14,557**	**15,164**	**17,166**	**17,295**	**18,135**	**17,807**	**16,770**	**15,423**	**14,390**	**15,088**	**15,870**	**15,818**	**15,160**	**16,108**	**16,891**	**17,635**

* The numbers in parentheses make allowance for the numbers missing in 1904 and 1905.

TABLE 4.—*Daily differences between disturbances of sun's surface in NW.+SE. quadrants and in NE.+SW. quadrants*—Continued.

For the years 1904-1909 the figures denote the areas of solar umbræ, while for 1910-1913 they denote total areas of sunspots and should be divided by 6 to make them commensurable with the umbral areas. In all cases only the part of the sun more than 30° from the central meridian is considered. *See Figures 5, 6, and 7.*

IN RELATION TO DAYS OF GREATEST DECREASE IN NORTHERN SECTION OF NORTH ATLANTIC OCEAN.

[Summary H 7-12.][4]

	Cases.	Days before.									Day of greatest decrease.	Days after.							
		9	8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8
1904:																			
Winter	12	576	594	512	687	523	422	522	663	511	585	615	500	582	332	346	252	236	176
Intermediate	20	618	557	479	359	431	443	763	801	692	599	454	589	574	604	673	747	796	617
Summer	18	358	398	300	323	365	353	421	391	405	375	442	349	370	444	279	473	518	479
Total																			
1905:																			
Winter	19	1,526	1,482	1,421	1,585	1,369	1,228	1,169	1,201	1,208	1,550	1,508	1,574	1,327	1,406	1,544	1,214	1,216	1,129
Intermediate	18	654	675	761	848	734	867	1,119	1,051	1,728	1,345	1,197	819	1,089	1,170	1,316	825	1,013	808
Summer	13	749	936	834	841	1,116	767	947	1,062	1,256	1,354	1,887	473	618	631	786	953	653	551
Total																			
1906:																			
Winter	18	694	775	772	673	591	885	782	1,087	796	1,013	849	830	1,065	856	620	824	963	800
Intermediate	16	574	615	579	464	527	568	743	461	563	602	724	696	613	698	596	539	702	756
Summer	16	605	485	711	788	447	579	899	919	474	454	566	876	868	817	757	740	925	689
Total																			
1907:																			
Winter	14	1,168	861	788	1,108	1,350	1,085	1,104	912	1,124	1,262	1,136	830	761	625	1,065	1,255	1,262	1,363
Intermediate	18	1,570	1,541	1,294	1,401	1,268	1,346	1,580	1,480	1,309	1,353	1,714	1,868	1,678	981	1,076	1,092	1,290	1,439
Summer	18	1,223	677	496	774	1,311	1,813	1,563	1,571	1,331	1,038	698	489	905	1,134	878	1,284	1,435	2,001
Total																			
1908:																			
Winter	12	236	281	498	419	512	483	385	288	212	249	331	558	743	762	494	288	223	311
Intermediate	20	845	754	592	826	603	759	953	1,115	875	1,033	580	382	890	704	771	896	745	703
Summer	18	588	912	1,219	1,116	768	594	766	646	645	561	538	538	794	1,239	1,338	953	943	752
Total																			
1909:																			
Winter	16	790	512	850	529	798	944	933	1,043	1,003	610	706	539	735	895	756	446	415	576
Intermediate	17	1,039	894	967	763	777	911	1,128	782	1,005	949	755	602	654	670	510	783	912	760
Summer	17	273	281	576	723	709	992	521	355	291	414	424	638	872	832	829	932	476	524
Total																			
1904-1909:																			
Winter	91	4,990	4,505	4,841	5,001	5,143	5,047	4,895	5,194	4,845	5,269	5,145	4,831	5,213	4,876	4,835	4,279	4,315	4,355
Intermediate	109	5,300	5,036	4,672	4,661	4,335	4,894	6,286	5,690	6,173	5,881	5,424	4,956	5,498	4,827	4,942	2,982	5,458	5,083
Summer	100	3,796	3,689	4,136	4,565	4,716	5,098	5,117	4,944	4,402	4,196	3,555	3,363	4,427	5,097	4,867	5,335	4,950	4,996
Total	**300**	**14,086**	**13,230**	**13,649**	**14,227**	**14,194**	**15,039**	**16,298**	**15,828**	**15,429**	**15,346**	**14,124**	**13,150**	**15,138**	**14,800**	**14,644**	**13,596**	**14,723**	**14,434**
1910:																			
Winter	21	3,519	2,314	2,873	3,022	2,832	2,525	1,798	1,653	2,166	2,631	1,872	1,554	2,635	3,051	2,712	2,209	1,745	2,306
Intermediate	14	3,193	3,769	3,514	2,846	2,484	2,169	2,164	2,208	2,400	2,370	2,211	2,189	1,069	1,104	681	764	1,222	1,122
Summer	15	2,413	2,009	1,707	1,271	1,626	2,502	1,914	1,810	1,320	1,474	2,581	3,119	2,133	2,035	2,355	1,931	1,159	3,152
Total																			
1911:																			
Winter	19	797	984	982	838	850	724	450	834	369	355	295	468	396	385	463	691	613	536
Intermediate	14	515	352	166	190	485	807	691	775	378	686	402	523	508	335	461	408	313	367
Summer	17	483	703	814	729	298	220	40	252	490	483	427	195	0	64	293	200	247	184
Total																			
1912:																			
Winter	15	794	769	1,015	490	338	62	212	546	620	373	359	147	115	499	321	384	113	258
Intermediate	19	739	769	693	330	579	708	841	111	72	47	396	1,009	1,397	1,475	754	414	636	637
Summer	16	435	641	779	498	282	358	185	237	273	378	443	207	231	256	228	230	40	440
Total																			
1913:																			
Winter	21	182	342	297	345	74	86	183	112	98	173	247	91	81	109	138	227	94	161
Intermediate	13	70	0	0	0	0	0	87	55	70	131	67	70	131	67	70	60	97	0
Summer	16	32	45	31	32	45	31	6	0	0	0	0	32	45	31	0	0	32	45
Total																			
1910-1913:																			
Winter	76	5,292	4,409	5.167	4,695	4,094	3,397	2,643	3,145	3,253	2,532	2,773	2,260	3,227	4,044	3,634	3,511	2,565	3,261
Intermediate	60	4,517	4,890	4,373	3,366	3,548	3,684	3,783	3,149	2,920	3,234	3,076	3,791	3,105	2,981	1,966	1,646	2,268	2,126
Summer	64	3,363	3,398	3,331	2,530	2,251	3,111	2,145	2,299	2,083	2,335	3,451	3,553	2,409	2,386	2,876	2,362	1,478	3,821
Total	**200**	**13,172**	**12,697**	**12,871**	**10,591**	**9,893**	**10,192**	**8,571**	**8,593**	**8,256**	**8,101**	**9,300**	**9,604**	**8,741**	**9,411**	**8,476**	**7,519**	**6,311**	**9,208**
Grandtotal 1904-1913																			
Winter																			
Intermediate																			
Summer																			
Total		**16,448**	**15,346**	**15,794**	**15,992**	**15,843**	**16,738**	**17,727**	**17,260**	**16,805**	**16,696**	**15,674**	**14,751**	**16,595**	**16,369**	**16,057**	**14,849**	**15,775**	**15,969**

TABLE 4.—*Daily differences between disturbances of sun's surface in NW.+SE. quadrants and in NE.+SW. quadrants*—Continued.

For the years 1904-1909 the figures denote the areas of solar umbræ, while for 1910-1913 they denote total areas of sunspots and should be divided by 6 to make them commensurable with the umbral areas. In all cases only the part of the sun more than 30° from the central meridian is considered.

IN RELATION TO DAYS OF HIGHEST GRADIENTS IN SOUTHERN SECTION OF NORTH ATLANTIC OCEAN.
[Summary J1—6]

	Cases.	Days before.							Day of highest gradient.	Days after									
		7	6	5	4	3	2	1		1	2	3	4	5	6	7	8	9	10
1904:																			
Winter	10	890	881	629	651	582	564	620	662	738	830	794	848	700	493	516	258	194	170
Intermediate	22	286	422	640	1,050	1,167	933	822	626	683	765	736	807	785	568	694	831	924	851
Summer	18	322	270	387	463	357	365	235	267	280	385	331	390	284	251	269	235	282	319
Total																			
1905:																			
Winter	20	1,182	1,263	1,584	1,622	1,628	1,550	1,350	1,385	1,265	1,202	1,575	1,376	1,527	1,867	1,224	1,301	1,581	1,618
Intermediate	19	1,698	1,405	1,287	1,153	1,292	1,478	1,367	1,204	870	1,033	1,066	1,058	1,172	1,093	1,041	1,391	1,631	1,236
Summer	11	263	573	700	764	873	752	592	452	486	706	662	873	821	717	528	638	488	475
Total																			
1906:																			
Winter	10	922	828	753	552	487	348	377	378	503	356	331	530	471	647	869	816	491	348
Intermediate	21	577	534	591	572	532	340	459	401	491	701	700	892	1,089	1,017	684	403	353	516
Summer	19	765	1,016	1,041	1,073	1,088	1,000	929	488	653	569	554	416	888	723	643	1,038	987	609
Total																			
1907:																			
Winter	11	953	856	625	533	566	779	1,094	1,135	1,453	1,086	1,062	720	472	485	503	723	889	1,496
Intermediate	22	1,363	1,259	1,445	1,792	2,018	2,328	2,653	2,197	1,624	891	516	795	1,088	1,471	1,361	1,327	1,019	882
Summer	17	443	676	844	743	668	901	824	1,186	1,433	1,317	1,181	816	715	682	968	966	972	813
Total																			
1908:																			
Winter	16	744	711	662	363	277	425	484	465	500	406	314	375	216	283	424	266	440	509
Intermediate	21	717	558	618	493	516	508	468	550	608	563	570	582	581	660	534	658	743	720
Summer	13	716	590	827	988	779	405	350	660	1,366	1,437	1,057	818	723	586	802	814	650	770
Total																			
1909:																			
Winter	22	848	953	903	979	1,086	1,131	1,212	1,413	962	1,080	1,207	1,082	1,172	1,220	1,338	1,100	1,197	1,000
Intermediate	13	813	734	600	530	317	397	488	610	530	571	551	394	432	498	532	508	415	387
Summer	15	713	610	130	644	933	1,121	911	1,281	871	949	786	684	633	635	630	595	892	988
Total																			
1904-1909:																			
Winter	89	5,539	5,492	5,156	4,700	4,649	4,797	5,137	5,438	5,421	4,990	4,502	4,083	4,558	4,995	4,874	4,464	4,792	5,138
Intermediate	118	3,954	4,912	5,181	5,590	5,842	5,984	6,257	5,588	4,806	4,524	4,202	4,611	5,147	5,307	4,846	5,108	5,085	4,596
Summer	93	3,222	3,735	4,229	4,675	4,698	4,544	3,841	4,334	5,088	5,263	4,571	3,997	4,064	3,594	3,840	4,286	4,271	3,973
Total	**300**	**12,715**	**14,139**	**14,566**	**14,965**	**15,189**	**15,325**	**15,235**	**15,360**	**15,315**	**14,777**	**13,275**	**12,691**	**13,769**	**13,896**	**13,560**	**13,858**	**14,148**	**13,707**
1910:																			
Winter	17	1,908	2,778	3,103	2,968	1,869	2,329	1,755	1,049	1,065	2,173	3,197	3,086	2,472	2,461	4,089	4,589	4,505	3,302
Intermediate	15	1,711	1,243	981	947	1,707	2,167	2,136	2,841	1,716	1,143	1,371	1,524	1,717	2,279	1,333	939	475	489
Summer	18	1,990	2,177	2,467	2,392	2,220	1,711	1,912	1,699	1,213	1,369	1,395	2,369	2,133	1,350	1,897	2,372	3,011	2,960
Total																			
1911:																			
Winter	19	0	0	17	0	0	66	78	62	210	261	226	164	17	273	355	299	286	415
Intermediate	26	1,027	1,334	1,498	1,367	688	940	1,037	796	1,308	1,484	1,801	2,176	1,802	1,394	989	872	1,155	1,651
Summer	15	285	364	246	301	4	0	16	18	52	80	312	341	330	307	79	172	45	20
Total																			
1912:																			
Winter	11	428	366	206	47	188	292	193	199	0	0	0	43	178	251	70	47	0	0
Intermediate	18	366	673	675	859	157	160	193	96	98	34	23	386	278	572	444	186	183	56
Summer	21	421	172	29	86	65	21	86	65	8	0	13	47	85	59	8	386	675	483
Total																			
1913:																			
Winter	13	93	163	25	8	0	36	104	94	121	58	17	0	121	135	47	103	66	74
Intermediate	16	0	44	56	56	12	87	115	167	87	142	212	212	125	70	0	0	0	0
Summer	21	6	6	0	32	73	104	72	31	0	0	0	0	0	0	0	0	0	0
Total																			
1910-1913:																			
Winter	50	2,429	3,307	3,351	3,023	2,057	2,723	2,130	1,404	1,396	2,492	3,440	3,293	2,788	3,120	4,561	5,038	4,807	3,791
Intermediate	75	3,104	3,294	3,210	3,229	2,564	3,354	3,481	3,900	3,209	2,803	3,407	4,198	3,922	4,315	2,766	1,997	1,813	2,196
Summer	75	2,702	2,719	2,742	2,811	2,362	1,836	2,086	1,813	1,273	1,449	1,720	2,757	2,548	1,716	1,984	2,930	3,737	3,463
Total	**200**	**8,235**	**9,320**	**9,303**	**9,063**	**6,983**	**7,913**	**8,697**	**7,117**	**5,878**	**6,744**	**8,567**	**10,248**	**9,258**	**9,151**	**9,311**	**9,965**	**10,357**	**9,450**
Grand total, 1904-13*:																			
Winter																			
Intermediate																			
Summer																			
Total		**14,088**	**15,692**	**16,117**	**16,476**	**16,353**	**16,644**	**16,685**	**16,546**	**16,295**	**15,901**	**14,703**	**14,399**	**15,312**	**15,421**	**15,112**	**15,519**	**15,874**	**15,282**

* In getting these last totals the figures for 1910-13 have been divided by 6 to reduce to same scale as earlier years.

TABLE 4.—*Daily differences between disturbances of sun's surface in NW.+SE. quadrants and in NE.+SW. quadrants*—Continued.

For the years 1904–1909 the figures denote the areas of solar umbræ, while for 1910–1913 they denote total areas of sunspots and should be divided by 6 to make them commensurable with the umbral areas. In all cases only the part of the sun more than 30° from the central meridian is considered.

IN RELATION TO DAYS OF HIGHEST GRADIENTS IN NORTHERN SECTION OF NORTH ATLANTIC OCEAN.

[Summary J 1—6.][a]

	Cases.	Days before.									Day of highest gradient.	Days after.							
		9	8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8
1904:																			
Winter	9	387	398	459	305	478	393	310	291	441	376	410	304	320	375	244	246	160	258
Intermediate	24	733	663	638	641	685	742	743	645	595	619	627	657	626	653	642	716	867	1,086
Summer	17	271	262	289	252	296	298	271	279	311	329	344	397	328	330	367	164	300	392
Total																			
1905:																			
Winter	22	1,345	1,645	1,927	1,714	2,045	1,936	1,584	1,425	1,287	1,141	1,381	1,592	1,237	1,421	1,431	1,511	1,336	1,048
Intermediate	13	805	699	505	426	407	629	514	781	484	652	841	892	612	464	450	895	557	574
Summer	15	926	840	781	765	558	556	899	842	840	957	1,081	930	980	724	923	1,244	1,476	1,203
Total																			
1906:																			
Winter	21	848	795	897	1,090	1,011	765	726	933	932	1,022	1,000	764	724	757	792	544	662	757
Intermediate	18	475	547	518	482	400	542	455	468	479	398	407	485	657	434	386	376	400	506
Summer	11	627	544	439	492	601	430	313	653	813	527	516	311	386	219	344	339	416	456
Total																			
1907:																			
Winter	10	543	354	410	375	455	505	779	1,314	1,265	714	435	394	293	301	448	330	442	561
Intermediate	21	1,144	841	784	742	1,277	2,365	3,016	3,110	2,539	1,574	1,031	1,031	1,250	1,464	1,344	900	822	571
Summer	19	1,246	838	581	318	656	1,106	1,754	1,509	1,119	1,076	745	467	428	853	868	805	1,142	1,145
Total																			
1908:																			
Winter	18	223	207	269	502	525	407	491	363	320	373	348	348	430	611	777	809	724	516
Intermediate	20	832	999	765	458	411	550	755	980	896	728	905	550	388	371	471	555	721	805
Summer	12	812	624	547	514	914	1,476	1,303	875	725	647	530	388	411	593	1,189	1,495	1,622	1,273
Total																			
1909:																			
Winter	8	512	575	492	360	290	263	314	321	335	314	383	336	205	248	272	280	210	259
Intermediate	22	1,807	1,664	1,436	1,581	1,611	1,386	1,377	1,570	1,380	1,275	1,483	1,452	1,391	1,304	895	685	691	762
Summer	20	385	481	395	496	368	461	507	563	577	667	657	609	790	821	756	607	573	628
Total																			
1904–1909:																			
Winter	88	3,858	3,974	4,454	4,346	4,804	4,269	4,204	4,647	4,580	3,940	3,957	3,738	3,209	3,713	3,964	3,720	3,534	3,399
Intermediate	118	5,798	5,413	4,646	4,330	4,791	6,214	6,860	7,554	6,373	5,246	5,254	5,067	4,924	4,690	4,188	4,127	4,058	4,304
Summer	94	4,267	3,589	3,032	2,837	3,393	4,327	5,047	4,721	4,385	4,203	3,873	3,102	3,323	3,540	4,447	4,654	5,529	5,097
Total	**300**	**13,923**	**12,976**	**12,132**	**11,513**	**12,988**	**14,810**	**16,111**	**16,922**	**15,338**	**13,389**	**13,084**	**11,907**	**11,456**	**11,943**	**12,599**	**12,501**	**13,121**	**12,800**
1910:																			
Winter	22	3,298	4,305	4,661	4,623	4,883	3,689	2,561	2,998	3,439	4,640	4,950	4,128	3,147	3,741	4,560	5,608	5,589	6,995
Intermediate	17	3,033	3,812	5,516	6,948	6,457	6,513	4,478	2,843	1,399	706	1,154	1,660	2,329	2,891	3,214	2,654	2,155	1,869
Summer	11	2,282	2,524	1,397	1,080	1,456	1,079	1,266	1,546	1,459	909	714	895	1,172	1,422	1,153	1,081	1,150	780
Total																			
1911:																			
Winter	11	748	502	519	322	556	963	1,135	1,019	952	551	149	43	340	547	696	812	785	516
Intermediate	25	1,899	2,151	2,188	1,688	1,176	885	967	1,092	1,390	1,549	1,778	1,847	1,943	2,226	1,962	1,684	942	760
Summer	14	362	182	23	216	460	721	730	382	245	284	448	344	332	126	46	60	30	172
Total																			
1912:																			
Winter	19	749	959	913	920	913	1,001	724	507	439	513	771	820	1,106	862	489	395	352	626
Intermediate	15	706	766	789	693	5	5	18	61	69	125	61	394	984	972	941	910	392	616
Summer	16	225	418	414	420	385	192	189	172	364	688	882	887	598	264	22	39	172	351
Total																			
1913:																			
Winter	26	76	142	271	201	189	189	68	200	120	30	20	14	18	113	162	92	185	136
Intermediate	18	143	154	125	130	97	0	60	157	157	97	60	97	0	147	152	70	60	97
Summer	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																			
1910–1913:																			
Winter	78	4,871	5,908	6,364	6,066	6,541	5,792	4,488	4,724	4,950	5,734	5,890	5,005	4,611	5,263	5,907	6,907	6,911	8,293
Intermediate	75	5,781	6,883	8,618	9,459	7,735	7,403	5,523	4,153	3,015	2,477	3,053	3,998	5,256	6,236	6,269	5,318	3,549	3,342
Summer	47	2,869	3,124	1,834	1,716	2,301	1,992	2,185	2,100	2,068	1,881	2,044	2,126	2,102	1,812	1,221	1,180	1,352	1,303
Total	**200**	**13,521**	**15,915**	**16,816**	**17,241**	**16,577**	**15.187**	**12,196**	**10,977**	**10,033**	**10,092**	**10,987**	**11,129**	**11,969**	**13,311**	**13,397**	**13,405**	**11,812**	**12,938**
Grand total 1904-1913:																			
Winter																			
Intermediate																			
Summer																			
Total		**16,187**	**15,629**	**14,935**	**14,387**	**15,751**	**17,441**	**18,144**	**18,752**	**17,010**	**15,071**	**14,915**	**13,772**	**13,451**	**14,162**	**14,832**	**14,735**	**15,080**	**14,956**

TABLE 4.—*Daily differences between disturbances of sun's surface in NW.+SE. quadrants and in NE.+SW. quadrants*—Continued.

IN RELATION TO DAYS OF LOWEST GRADIENTS IN SOUTHERN SECTION NORTH ATLANTIC OCEAN.

[Summary J 7—12.][7]

	Cases.	Days before.									Day of lowest gradient.	Days after.									
		9	8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8	9	10
1904:																					
Winter	7			106	83	119	133	245	150	127	194	247	232	178	175	215	168	178	153	147	183
Intermediate	15			279	184	232	219	285	290	230	248	227	203	348	490	480	413	521	674	877	1,042
Summer	28			674	673	713	594	803	895	899	833	744	803	776	862	773	627	679	739	684	654
Total																					
1905:																					
Winter	16			1,283	1,451	1,547	1,388	1,931	1,264	1,353	1,230	982	1,085	1,304	1,529	1,089	1,374	1,363	1,585	1,416	1,443
Intermediate	14			719	1,137	992	1,028	1,116	1,348	1,020	945	1,036	1,119	705	978	1,423	1,371	865	786	812	748
Summer	20			1,344	1,237	1,245	1,386	1,283	1,161	952	996	1,352	1,136	1,171	1,472	1,671	1,616	1,709	1,512	1,677	1,993
Total																					
1906:																					
Winter	14			683	535	578	662	552	607	526	389	403	659	796	855	855	536	459	360	517	787
Intermediate	14			326	295	323	294	386	402	562	420	330	314	344	522	757	654	534	477	517	584
Summer	22			930	962	701	989	1,145	1,128	1,167	997	872	1,077	974	972	726	811	673	558	614	741
Total																					
1907:																					
Winter	13			735	1,028	973	961	716	975	890	732	865	643	869	1,175	1,039	1,164	1,387	1,084	878	703
Intermediate	14			1,066	524	651	861	960	1,008	1,079	692	706	517	424	371	463	821	879	963	1,001	1,314
Summer	23			2,451	1,740	1,229	1,362	1,322	1,685	2,800	2,923	2,258	1,519	893	943	1,227	1,725	2,191	2,015	2,000	1,916
Total																					
1908:																					
Winter	5			137	40	37	35	0	30	34	104	144	208	218	201	374	457	528	492	524	413
Intermediate	15			697	495	326	657	475	540	595	454	570	366	396	378	550	492	666	674	637	739
Summer	30			1,097	1,322	955	999	1,115	1,403	1,100	1,309	1,142	880	759	924	992	956	983	1,172	949	916
Total																					
1909:																					
Winter	16			972	1,057	1,133	1,056	1,130	1,007	1,113	774	616	601	645	766	779	683	679	616	519	524
Intermediate	13			462	248	422	509	837	962	1,024	1,076	723	689	478	505	600	438	595	761	624	592
Summer	22			261	448	803	758	703	981	800	486	560	606	690	843	779	573	601	1,079	1,379	1,728
Total *																					
1904–1909:																					
Winter	71			3,916	4,195	4,387	4,235	4,574	3,133	4,043	3,424	3,271	3,428	4,010	4,701	4,311	4,382	4,594	4,290	4,001	4,023
Intermediate	85			3,549	2,883	2,946	3,568	4,059	4,550	4,500	3,482	3,592	3 208	2,695	3,244	4,273	4,189	4,060	4,328	4,468	5,019
Summer	145			6,746	6,332	5,498	6,068	6,328	7,176	7,660	7,438	6,892	5,924	5,220	5,962	6,162	6,297	6,832	7,073	7,303	7,948
Total	**301**			**14,211**	**13,410**	**12,831**	**13,871**	**15,861**	**14,859**	**16,203**	**14,354**	**13,755**	**12,560**	**11,925**	**13,907**	**14,746**	**14,868**	**15,486**	**15,691**	**15,772**	**16,990**
1910:																					
Winter	20			3,863	4,662	4,540	3,210	4,212	3,115	3,269	2,675	2,603	3,026	3,684	2,864	1,707	994	1,360	2,080	2,132	1,773
Intermediate	16			1,905	1,631	1,304	1,301	1,494	1,590	1,861	1,854	1,703	1,076	165	304	779	1,093	1,161	908	1,749	1,263
Summer	14			1,354	1,303	1,869	1,676	2,458	2,980	1,883	2,479	3,178	2,775	3,529	4,419	3,369	4,215	4,900	3,631	3,065	3,859
Total																					
1911:																					
Winter	19			494	502	662	811	908	864	830	453	637	760	582	327	542	418	219	286	492	496
Intermediate	12			963	841	482	459	317	527	743	903	954	819	718	351	298	355	420	437	597	689
Summer	19			595	409	475	372	454	383	255	197	172	178	252	383	353	262	198	105	54	205
Total																					
1912:																					
Winter	11			239	33	136	333	840	1,243	849	351	34	96	564	816	919	386	136	77	111	524
Intermediate	18			414	333	241	211	418	919	1,243	1,421	596	760	518	1,216	1,338	1,493	1,032	527	404	98
Summer	21			410	371	418	646	830	842	525	598	707	775	829	1,042	593	370	214	235	358	453
Total																					
1913:																					
Winter	21			58	17	8	51	59	101	142	144	154	51	95	271	170	119	73	12	0	25
Intermediate	12			55	70	60	97	0	0	0	0	44	12	60	97	0	60	157	97	0	0
Summer	17			0	0	0	0	0	0	0	0	0	32	77	76	31	0	32	77	76	63
Total																					
1910–1913:																					
Winter	71			4,654	5,214	5,346	4,405	6,019	5,323	5,090	3,623	3,358	3,933	4,925	4,278	3,338	1,917	1,788	2,455	2,735	2,818
Intermediate	58			3,337	2,875	2,087	2,068	2,229	3,036	3,847	4,178	3,297	2,667	1,461	1,968	2,415	3,001	2,770	1,969	2,750	2,050
Summer	71			2,359	2,083	2,762	2,694	3,742	4,205	2,663	3,274	4,057	3,760	4,687	5,920	4,346	4,847	5,344	4,048	3,553	3,580
Total	**200**			**10,350**	**10,172**	**10,195**	**9,167**	**11,990**	**12,564**	**11,590**	**11,075**	**10,712**	**10,360**	**11,073**	**12,166**	**10,099**	**9,765**	**9,902**	**8,472**	**9,038**	**8,448**
Grand total, 1904–1913:																					
Winter																					
Intermediate																					
Summer																					
Total				**15,936**	**15,105**	**14,530**	**15,499**	**17,859**	**16,553**	**18,135**	**16,200**	**15,440**	**14,287**	**13,769**	**15,935**	**16,429**	**16,496**	**17,136**	**17,103**	**17,278**	**18,398**
Winter		**7,938** 15,750	**7,773** 15,200	**17,474**	**17,409**	**17,857**	**17,843**	**19,030**	**17,519**	**20,053**	**18,077**	**16,602**	**15,797**	**14,676**	**15,935**	**16,835**	**16,979**	**18,165**	**17,287**	**8,919** 17,100	**8,228** 15,750
Intermediate		**10,544** 19,410	**10,501** 19,320	**17,937**	**15,335**	**16,769**	**18,651**	**21,094**	**23,381**	**22,437**	**19,461**	**18,243**	**17,392**	**15,434**	**16,756**	**17,389**	**17,906**	**17,363**	**18,572**	**9,818** 92,180	**10,149** 19,860
Summer		**9,167**	**7,658**	**19,415**	**18,242**	**17,841**	**20,231**	**21,666**	**22,070**	**23,292**	**22,448**	**21,288**	**18,583**	**17,852**	**19,822**	**20,986**	**21,296**	**23,545**	**21,796**	**12,403** 23,820	**14,748***
Year				54,826	50,986	52,467	56,725	61,790	62,970	65,782	59,886	56,133	51,772	47,962	52,513	55,210	56,181	59,073	57,655		

* 51 used by mistake.

Total by seasons for lowest gradient in southern section, greatest decrease in southern section, highest gradient in **northern section,** and **greatest increase in northern section,** 1904–1909. For 1910–1913 see Summary **H** 1—6.[2]

TABLE 4.—*Daily differences between disturbances of sun's surface in NW.+SE. quadrants and in NE.+SW. quadrants*—Continued.

IN RELATION TO DAYS OF LOWEST GRADIENTS IN NORTHERN SECTION OF NORTH ATLANTIC OCEAN.

[Summary J 7-12.][8]

	Cases.	Days before.									Day of lowest gradient.	Days after.							
		9	8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8
1904:																			
Winter	6	181	182	152	213	138	293	344	322	237	257	340	162	231	158	167	110	116	102
Intermediate	16	436	379	446	587	704	663	718	682	421	568	538	463	349	438	453	686	691	674
Summer	28	527	627	763	836	966	877	752	678	762	773	798	783	656	591	635	684	735	641
Total																			
1905:																			
Winter	13	1,095	662	744	619	535	657	789	1,158	846	734	638	715	1,047	902	1,232	762	1,371	1,715
Intermediate	17	809	537	616	680	818	980	1,177	959	1,070	925	994	725	765	777	899	658	832	795
Summer	20	2,047	2,482	2,612	2,471	2,452	2,152	2,052	2,080	1,940	1,690	1,302	1,107	962	672	641	1,132	970	817
Total																			
1906:																			
Winter	15	660	778	699	697	733	927	609	819	692	825	1,912	579	993	672	596	731	689	535
Intermediate	17	681	545	591	698	646	559	538	439	633	715	736	686	546	457	407	422	552	625
Summer	18	484	579	952	987	741	725	673	861	697	739	487	676	650	723	680	628	756	663
Total																			
1907:																			
Winter	28	2,306	2,044	2,324	2,330	2,023	2,246	2,524	2,624	2,904	2,800	2,822	2,382	2,545	3,016	2,843	2,647	2,442	2,297
Intermediate	10	872	938	962	956	555	410	520	566	577	522	1,121	1,148	931	300	426	517	643	636
Summer	12	1,198	1,229	883	1,075	882	605	895	925	1,017	1,188	1,083	930	842	547	481	529	1,001	913
Total																			
1908:																			
Winter	18	542	701	770	737	847	700	531	461	357	329	409	626	543	515	468	290	359	516
Intermediate	12	255	165	163	405	577	606	528	559	421	365	227	233	441	406	453	574	552	400
Summer	20	652	996	897	846	719	832	1,096	872	779	929	858	890	908	988	684	797	907	707
Total																			
1909:																			
Winter	24	1,395	1,175	970	935	1,165	1,112	1,164	1,191	1,073	858	973	922	1,084	1,128	984	1,017	1,165	1,367
Intermediate	10	363	407	678	631	535	407	350	356	656	354	353	226	88	152	339	687	840	355
Summer	16	706	902	1,305	1,557	1,433	1,137	502	298	212	506	732	1,103	1,375	763	455	417	692	953
Total																			
1904–1909:																			
Winter	104	6,179	5,536	5,659	5,531	5,441	5,935	5,961	6,575	6,109	5,803	6,094	5,386	6,443	6,391	6,290	5,557	6,142	6,532
Intermediate	82	3,416	2,971	3,556	3,957	3,845	3,625	3,831	3,561	3,778	3,369	3,969	3,581	3,120	2,530	2,977	3,544	4,110	3,449
Summer	114	5,614	6,806	7,412	7,772	7,197	6,328	5,970	5,714	5,407	5,825	5,260	5,489	5,393	4,284	3,576	4,187	5,061	4,694
Total	**300**	**15,209**	**15,313**	**16,627**	**17,260**	**16,483**	**15,888**	**15,762**	**15,850**	**15,294**	**14,997**	**15,323**	**14,456**	**14,956**	**13,205**	**12,843**	**13,288**	**15,313**	**14,675**
1910:																			
Winter	14	2,003	2,805	3,997	5,257	4,631	3,241	1,874	639	1,006	2,174	2,616	2,820	2,866	2,217	2,150	1,924	1,932	1,964
Intermediate	17	2,544	1,970	2,117	2,129	1,533	2,158	1,852	2,262	2,281	2,256	2,713	1,667	1,444	1,349	1,115	1,711	1,290	1,435
Summer	19	2,895	2,124	1,838	1,839	3,208	3,154	1,398	1,839	2,029	2,233	3,324	3,187	2,624	2,693	2,985	2,555	1,908	3,873
Total																			
1911:																			
Winter	19	551	310	296	129	144	86	139	380	412	476	662	602	522	537	403	289	263	135
Intermediate	14	468	508	381	438	494	544	721	460	673	702	663	553	566	444	368	299	445	369
Summer	17	610	463	433	674	664	859	628	526	375	152	359	217	240	271	81	50	21	0
Total																			
1912:																			
Winter	15	212	248	239	60	73	99	213	610	443	335	0	0	0	0	110	113	70	47
Intermediate	14	552	596	685	325	518	626	739	62	64	99	506	798	951	957	290	511	552	204
Summer	21	1,028	853	766	785	715	563	64	344	434	451	299	406	433	643	673	446	216	452
Total																			
1913:																			
Winter	14	166	275	253	139	135	76	17	25	65	85	120	90	168	176	93	17	0	0
Intermediate	15	0	0	0	0	0	0	44	12	87	99	82	0	131	67	70	0	0	0
Summer	21	45	31	0	38	45	31	6	0	0	0	32	45	31	0	0	32	77	76
Total																			
1910–1913:																			
Winter	62	2,932	3,638	4,785	5,585	4,983	3,602	2,243	1,654	1,926	3,070	3,398	3,512	3,556	2,930	2,756	2,343	2,265	2,146
Intermediate	60	2,564	1,374	3,183	2,892	2,545	3,328	3,356	2,796	3,105	3,156	3,964	3,018	3,092	2,817	1,843	2,521	2,287	2,008
Summer	78	4,578	3,471	3,037	3,336	4,632	4,607	2,096	2,709	2,838	2,836	4,014	3,855	3,328	3,607	3,739	3,083	2,222	4,401
Total	**200**	**10,074**	**8,483**	**11,005**	**11,813**	**12,160**	**11,537**	**7,695**	**7,159**	**7,869**	**9,062**	**11,376**	**10,385**	**9,976**	**9,354**	**8,338**	**7,947**	**6,774**	**8,555**
Grand total, 1904–13:																			
Winter																			
Intermediate																			
Summer																			
Total		**16,888**	**16,727**	**18,461**	**19,229**	**18,510**	**17,811**	**17,045**	**17,043**	**16,606**	**16,507**	**17,219**	**16,187**	**16,619**	**14,764**	**14,233**	**14,613**	**16,442**	**16,101**

TABLE 5.—*Umbral areas in relation to periods of marked barometric disturbance in Atlantic Ocean involving a sudden decrease and low gradients in southern part accompanied by a great increase in strength of gradients in northern part. (See fig. 8.)*

[Summary K.]

	Cases.	Days before.										Day of disturbance.	Days after.									
		10	9	8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8	9	10
1904	28	770	757	626	612	564	640	704	1,001	1,095	680	698	769	474	516	705	756	693	695	508	843	1,060
1905	29	2,310	2,020	1,215	1,053	1,248	2,156	1,802	2,490	2,433	2,420	2,677	2,347	2,695	2,141	1,735	1,539	2,015	1,744	2,145	2,655	2,302
1906	35	1,451	1,108	1,307	1,248	1,442	1,208	1,380	1,272	1,543	1,803	1,741	1,675	1,400	1,341	1,473	1,409	1,175	1,156	1,127	1,358	1,555
1907	29	3,153	2,881	2,437	1,782	1,325	1,191	1,462	1,628	1,726	2,872	3,146	2,761	2,178	1,461	1,342	1,354	1,746	1,951	2,138	2,623	2,787
1908	28	948	1,071	1,169	1,195	1,210	886	1,018	694	840	941	1,241	964	906	982	604	900	923	1,175	1,457	1,025	968
1909	25	1,665	968	974	1,159	1,383	1,422	983	967	722	1,270	1,089	1,088	715	782	796	861	988	897	1,207	1,157	981
Total	**174**	**10,297**	**8,805**	**7,728**	**7,049**	**7,172**	**7,503**	**7,349**	**8,052**	**8,339**	**9,986**	**10,592**	**9,604**	**8,368**	**7,223**	**6,655**	**6,819**	**7,540**	**7,618**	**8,582**	**9,661**	**9,653**

The upper curves in these portions of figs. 5 and 6 show that the solar relationship is distinct at all seasons. Of the 12 solid lines in columns B, C, F, and G one shows a maximum on the day of reference, 4 show a maximum on the first day before, 4 on the second day before, and 3 on the third day before. Among the dotted lines there is

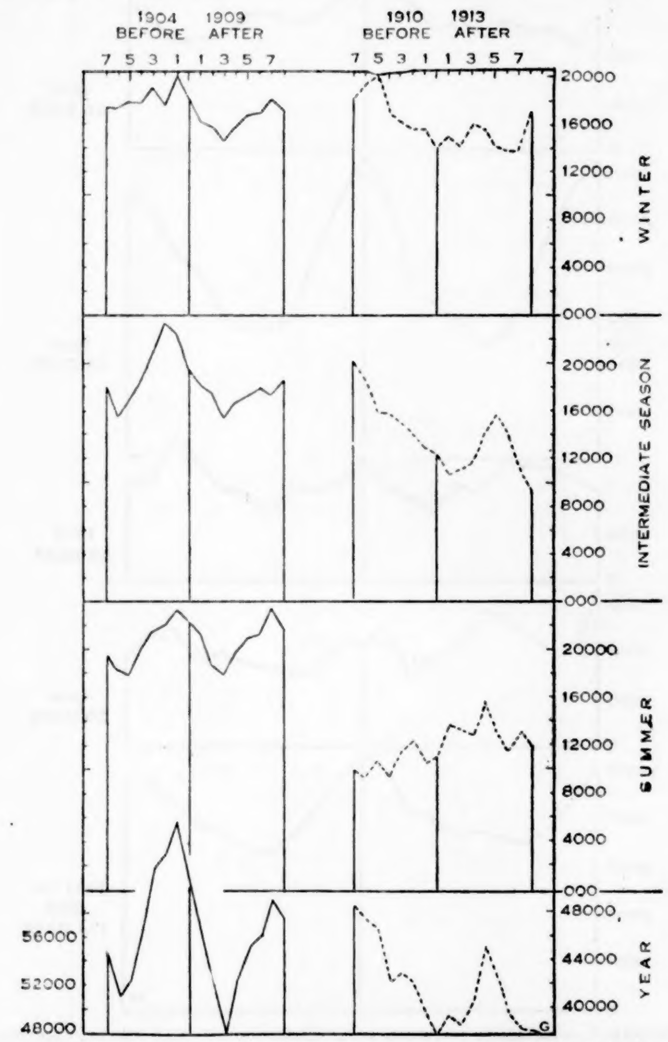

FIGURE 7.—Solar relationships of the seasons (based on Table 3).

much less regularity. Nevertheless, there seems to be a tendency toward a maximum several days earlier than that of the solid lines. This can best be seen in figure 7 where the four lines for each season in columns B, C, F, and G of figures 5 and 6 have been averaged. The strong resemblance among the solid lines on the left of figure 7 means that at times of many sunspots the response of the earth's weather to solar changes is essentially the same at all seasons.

The dotted lines on the right in figure 7, representing the years 1910–1913, show no such regularity as do the corresponding solid lines for 1904–1909. The two upper dotted lines, however, for winter and the intermediate season, display a trace of similarity. Moreover, in some respects they show analogies with the similar lines for the preceding period of abundant sunspots. For instance, their maximum, five to seven days before the day of reference, presumably corresponds to the maximum which occurs one or two days before the day of reference at times of many spots. Moreover, their minimum just after the day of reference probably corresponds to the minimum that occurs three days after the day of reference at times of many spots. The essential difference between times of many and few spots seems to be that when sunspots are few they are also weak. Thus it takes some days for their effects to become manifest. When sunspots are numerous, on the contrary, the effect is quickly felt, but is apparently soon neutralized by the appearance of new areas of solar disturbance.

As to the summer line for 1910–1913 it is interesting to note not only that it departs most widely from the type to which the others in figure 7 approximate, but that it is also the one representing the least degree of solar spottedness, as appears from its low position. When sunspots are least numerous the terrestrial effect with which they are connected is presumably so slight that it is completely masked.

Comparison between unusually stormy periods in the North Atlantic and solar quadrant differences for 1904–1909.—Let us now test our results in still another way. We have seen that the supposed relationship between the sun and the weather is most clearly visible under two distinct conditions: (1) When a sudden flattening of the barometric gradients in the southern section of the North Atlantic Ocean causes the gradients to be unusually gentle in that region, and (2) when a marked increase in the gradients of the northern section causes them to be unusually steep. Let is now see what happens when the North Atlantic is visited by barometric disturbances such that these two sets of conditions occur on the same day or when the northern set follow within a day after the southern. For each of the six years, 1904–1909, I have selected from 25 to 35 periods of one or two days showing these conditions with greatest distinctness. The selection was made with absolutely no knowledge of the accompanying solar conditions. The quadrant differences of the sun, according to our definition of that term, were then tabulated for 10 days before and after the first day of such disturbances. The results for individual years are given in figure 8 and Table 5. The characteristic features of the curves of figure 8 are a maximum at

or near the central day of reference, two symmetrically placed minima from four to six days before and after the central day, and a rise at either end. The summary curve at the bottom brings out the essential features with great clearness. *In view of the large number of days, 174, on which this curve is based, its symmetry is astonishing. So too is the fact that there is a difference of 50 per cent between the lower and higher portions. Such a curve could scarcely be the result of accident. Apparently there must be a real and important relationship.*

The fact that the curves of figure 8 rise at either end is the necessary result of our assumed conditions. The central maximum indicates large quadrant differences. Such differences generally mean that a large group of spots is located in only one of the four marginal areas indicated by the letters A to D in figure 3. Suppose that a group is brought into view by rotation on the margin near B and causes a barometric disturbance. Since a complete solar rotation takes 26 or 27 days, this group will be visible to the earth for about 13½ days. Since a spot apparently produces its chief effect soon after its appearance on the solar margin, it must reach a corresponding point on the other margin after an interval of 10 to 14 days. Accordingly it would then be expected to produce a second barometric disturbance. Suppose that the first of these disturbances is selected for use in preparing figure 8. There is bound to be an excess of quadrant differences not only at the time of the disturbance, but from 10 to 14 days later. If the second is chosen, it is bound to be preceded by a marked quadrant difference some 10 to 14 days earlier. Thus the rise of the curves at the two ends in figure 8 is a necessary consequence of the way in which our figures are tabulated. It must occur if the central rise occurs. Its absence would merely show that disturbances of the solar atmosphere die out while passing from an effective position on one margin to an effective position on the other. Hence the symmetrical rise of the curves of figure 8 at either end is as significant as is the rise in the center.

One more fact is emphasized by figure 8. In the previous diagrams we have generally found an interval of from one to three days between the supposed solar cause and the terrestrial response. In the case of the years with few spots this increases to six or seven days. In the present case, however, where we are using only the most extreme barometric disturbances during years of abundant sunspots, it ranges from zero to two days. Apparently the stronger the relationship the greater the synchronism of cause and effect.

Suppose we arrange the upper curves of figure 8 in the order determined by the intensity and regularity with which three conditions make themselves apparent: (1) The height of the central maximum; (2) the symmetry of the depressions on either side; and (3) the synchronism between the solar cause and the supposed terrestrial effect. In order to avoid accidental irregularities we may well use the dotted lines which have been smoothed by the simple formula $\frac{1}{4}(a+2b+c)=b$. The order seems to accord closely with that of the sunspot numbers for the respective years, which appear as follows when arranged according to magnitude:

1907	64.5	1908	47.3
1905	58.6	1909	44.3
1906	52.8	1904	41.1

The curve for 1907 is unquestionably the most characteristic. That year sunspots were more numerous than at any time since 1895. The dotted line for 1905 is almost as regular as for 1907, while 1906 rivals the other two in symmetry, although the contrast between the maximum and the two flanking minima is less pronounced. In 1908 the central part of the curve is more

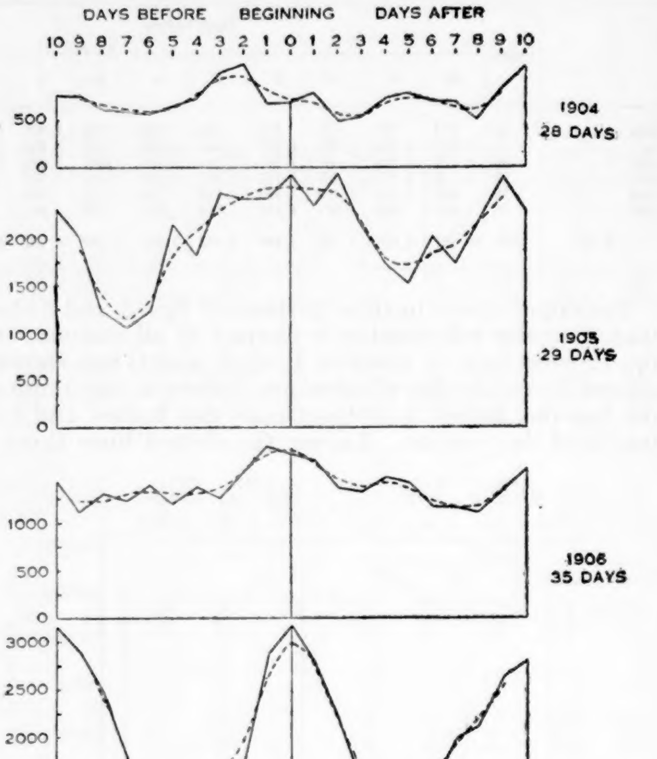

Figure 8.—Relation between solar disturbances and stormy periods in the North Atlantic Ocean. (Cf. Table 4.)

Ordinates indicate the differences between the areas of umbræ more than 30 degrees from the sun's center in the NW.+SE. and NE.+SW. quadrants.

Abscissæ indicate time with reference to barometric disturbances characterized by a fall of the gradients to a low level in the southern or high pressure area of the North Atlantic accompanied, or followed within two days by a marked increase in the strength of the gradients in the northern or low pressure area.

Number of days given on the right indicate the number of disturbances in the North Atlantic.

The zero of the abscissæ is the first day of each disturbance.

regular than in 1906, but the preceding minimum is not well developed; 1909 is still more irregular because the central maximum is lower than another maximum occurring five days earlier, at a time when the well-developed curves show a minimum. Finally in 1904, which had the lowest sunspot number, the maximum definitely parts company with the day of reference, and occurs two days before. Thus for these six years it appears that the more abundant the sunspots the more pronounced is the terrestrial response, and the more promptly does the response follow the supposed cause.

(*To be continued.*)

BREATHING WELL IN CALIFORNIA.

Mr. N. M. Cunningham, observer at Red Bluff, Cal., writes under date of April 18, 1918, that there is a known "breathing well" on the ranch of D. Ewing, 6 miles northwest of Red Bluff, Cal. The well is 60 feet deep, about 3 feet in diameter and tightly covered by a board platform tapped by a small iron pipe carrying a small whistle which always gives warning of approaching storms by its sounding. Mr. Cunningham has compared the "breathings" of the well with his station barograph record at Red Bluff and finds that the well "breathes in" when the barometer is rising, and "breathes out" when it is falling.

This further confirms the previous experiences with such wells; but an interesting and perhaps very valuable quantitative study of this well's behavior could be made by recording its changes in some detail and analyzing them with respect to atmospheric pressure changes in the manner followed by E. G. Bilham (see abstract and reference in this REVIEW for January, 1918, p. 26).—C. A., jr.

SECTION III.—FORECASTS.

FORECASTS AND WARNINGS FOR MARCH, 1918.

By H. C. FRANKENFIELD, Supervising Forecaster.

[Weather Bureau, Washington, Apr. 2, 1918.]

GENERAL PRESSURE DISTRIBUTION OVER THE NORTHERN HEMISPHERE EXCEPT EUROPE AND INTERIOR ASIA.

Over the Pacific Ocean, as indicated by the observations at Midway Island and Honolulu, pressure was generally low after the first few days of the month. After the 24th reports were incomplete.

Over the Aleutian Islands high pressure ruled throughout the month except from the 25th to the 27th, inclusive, when it was moderately low. From the 7th to the 9th, inclusive, the pressure was abnormally high, with a crest of 30.98 inches on the 7th.

The Aleutian high pressures also extended in virtually the same marked form over Alaska during the first decade of the month, but thereafter pressure over Alaska was generally low, except between the 19th and 24th, when it was moderately high over northern Alaska. There was, however, but one period of pronounced depression, the 12th and 13th, with a minimum of 28.70 inches at Valdez on the 13th.

Over the United States proper conditions were not unusual for the month of March. During the first two decades there was a fairly uniform alternation of high and low pressure periods, each of two or three days duration, with three quite marked cyclones and one anticyclone, the latter that of the 15th. During the third decade of the month pressure was generally, although not decidedly, low, especially from the Ohio Valley eastward and southward.

Over the northern portion of the western Atlantic Ocean low pressure prevailed almost uniformly, with a minimum of 28.84 inches at Saint John's, N. F., on the 16th. Over the central and southern portions pressure was higher, Bermuda and Turks Island ruling moderately high until after the 20th when there was a reaction to moderate subnormal conditions.

STORM WARNINGS.

On the morning of the 2d there was a moderate disturbance over northern Lake Superior. It moved rapidly eastward during the next 24 hours, with considerable increase in intensity attended by gales throughout the Lakes region, New York, and New England. As the development of the storm was not of marked character until after it reached New England, the only strong winds were those from the northwest, and, as they could continue for only a few hours, no storm warnings were ordered. The highest wind velocity reached was 72 miles an hour from the northwest at New York City during the night of March 2–3.

On the morning of the 5th pressure was low over the Central Plains States and the upper Mississippi Valley, with a cold high area to the northwestward. By the night of the 5th the disturbance was central over Illinois, and a warning of strong northerly winds, with snow and much colder weather, was sent to open ports on Lake Michigan. Cold winds, with some local snows, followed, but the winds were no more than fresh. The disturbance drifted slowly eastward to New England; on the morning of the 7th there was a redevelopment off the Virginia coast, and, accordingly, northeast storm warnings were ordered on the New England coast from Block Island, R. I., to Provincetown, Mass., and on the eastern Maine coast, for strong northeast to north winds that would diminish by the following morning. Some northerly strong winds occurred during the afternoon of the 7th on the southern New England coast, but the disturbance rapidly disintegrated, and the warnings were lowered at 9 p. m.

In the meantime another disturbance of marked character had moved in by way of the northern California coast, and by the night of the 8th it was central over eastern Colorado, with a strong gradient to the northeastward. Advisory messages were then sent to the open ports on Lake Michigan for strong northeast winds, with snow on the following day. On the morning of the 9th the storm was central over extreme eastern Nebraska with a barometer reading of 29.10 inches at Lincoln, and strong easterly winds, with snow, prevailed on Lake Michigan. The warnings were repeated on the evening of the 9th, at which time snow continued on Lake Michigan, with northeasterly to northerly gales, that reached a velocity of 60 miles an hour at Green Bay, Wis. At 5 p. m. on the same day southwest warnings were ordered on the Atlantic coast from Eastport, Me., to Southport, N. C., for south winds shifting to southwest and reaching gale force on the following day. The winds occurred as forecast, so far as velocity was concerned, but not as to direction on the New England coast; and on the morning of the 10th, with the storm central over Long Island, the warnings were changed to northwest and extended southward to Jacksonville, Fla. During the day, northwest gales occurred quite generally, with a maximum velocity of 84 miles an hour at New York City, and of 60 miles an hour at Norfolk, Va.

Another storm from the North Pacific reached eastern Lake Superior by the morning of the 12th, and at 11 a. m. southwest warnings were ordered from Delaware Breakwater, Del., to Eastport, Me., for strong southwest winds, shifting to west and northwest on the following day. These warnings were not generally justified owing to the rapid approach of another disturbance from the west, although a velocity of 44 miles an hour was reached at Nantucket, Mass.

On the morning of the 13th, the second western disturbance just referred to was central over northern Kansas, and advisory messages were sent to open ports on Lake Michigan for strong northeast to north winds, with snow or rain. These conditions occurred as forecast, although the winds were only moderately strong.

On the morning of the 14th the disturbance was central over northern Ohio, and at 2:30 p. m., after a special observation had been received, southwest warnings were ordered on the Atlantic coast from Southport, N. C., to Baltimore, Md., and southeast warnings from Delaware Breakwater, Del., to Eastport, Me., winds to shift to west and northwest by the following morning. Only

moderately strong winds occurred in advance of the storm center; but on the 15th, when it was over Nova Scotia, the warnings were changed to northwest, and northwest gales occurred during the day. By the night of the 15th conditions had become more moderate, and the warnings were lowered at 9 p. m.

On the morning of the 15th another disturbance was central over southwestern Alaska; during the next 48 hours it moved to northwestern Ontario in quite marked form, and at 2:30 p. m. southwest warnings were ordered on the Atlantic coast from Sandy Hook, N. J., to Eastport, Me. Strong southwest winds occurred as forecast, with a maximum velocity of 60 miles an hour, from the west at New York City. The wind subsided rapidly after 8 p. m. of March 17, and on the following morning the warnings were lowered.

There were no further warnings during the month.

COLD WAVE AND FROST WARNINGS.

There was a rapid rise in pressure over the northern portion of the country following the storm of March 2-3; and on the morning of March 4 there was a moderate cold wave in northern New England, for which no warnings had been issued.

A cold wave from the northwest followed the Plains States' disturbance of the 4th and 5th, and on the morning of the 5th cold-wave warnings were ordered for upper Michigan. At night and the following morning they were ordered for southern lower Michigan, northern Indiana, and northern Ohio. A decided fall in temperature followed, and the warnings were verified as a whole.

Following a severe disturbance that was over eastern Nebraska on the morning of March 9, cold-wave warnings were ordered for Kentucky, Tennessee, north Michigan, southern Ohio, and western West Virginia. A decided fall in temperature followed, amounting to as much as 44 degrees in 24 hours in the upper Ohio valley; and the warnings were generally verified.

On the morning of the 10th, with a storm central over northern Ohio, cold-wave warnings were ordered for the Middle Atlantic States, western New England, the interior of the southern Atlantic and eastern Gulf States; and frost warnings for northern Florida and along the eastern Gulf coast. These warnings were verified in nearly all localities, except in the extreme South, where there was no frost.

On the morning of the 15th marked high pressure prevailed over the greater portion of the country, with a crest of 30.72 inches over South Dakota; and frost warnings were sent to eastern North Carolina, the interior of northern and central South Carolina, and the northern portions of Georgia, Alabama, and Mississippi, with a possibility of extension into the central portions of the three last-named States. Cloudy weather intervened, however, during the night, and there were no frosts south of Tennessee and North Carolina.

On the morning of the 17th, with high pressure and low temperature over eastern Texas, frost warnings were ordered for interior Mississippi; but again cloudy weather intervened, although freezing temperature was reported at Corinth, in the extreme northern portion of the State, and frost occurred in Tennessee and western North Carolina.

There were no further frost warnings until the morning of the 25th, when pressure was moderately high over the lower Missouri Valley, and low off the North Carolina coast. Frost warnings were ordered for Tennessee and the northern portions of the South Atlantic and East Gulf districts. These warnings were verified, except in Mississippi and Alabama.

Local frosts occurred in southern Virginia and North Carolina on the 29th, 30th, and 31st, although no warnings were sent, except on the 29th. The frosts were of little consequence.

SPECIAL WARNINGS.

On the morning of the 9th, with the previously mentioned severe disturbance over eastern Nebraska and high pressure to the northeastward, heavy snow warnings were ordered for upper Michigan and northern lower Michigan. Heavy snow occurred as forecast and extended eastward to northern New England, while over southern lower Michigan there was a considerable quantity of snow and ice.

The Chief Hydrographer of the Panama Canal reported a norther on the 11th and 12th. At Colon the wind reached a velocity of 30 miles an hour from the east on both days, while at Balboa Heights the maximum velocity was 35 miles an hour from the north on the 12th. This norther was not forecast, as precedent conditions were somewhat doubtful. No damage was done.

A warning of strong northerly winds was sent on the 15th, when a great cyclone on the North Atlantic coast was followed by an equally great anticyclone, with a strong gradient between. The anticyclone, however, materially changed its formation during the ensuing 24 hours, and no winds of consequence occurred in the Canal Zone.

WARNINGS FROM OTHER DISTRICTS.

Chicago, Ill., forecast district—The special advices issued in the Chicago forecast district in the month of March were confined to cold-wave and cattle warnings during the first decade.

On the evening of the 3d a cold wave appeared in the British Northwest, with an extensive low-pressure area in the sections lying to the south, and cold-wave and cattle warnings were issued on the following day to northwestern districts and extended on the 4th and 5th southward over the middle Plains States and eastward over the upper Mississippi valley and western Lakes region. Advices of conditions dangerous to cattle were issued at the same time to stockmen in Montana, Wyoming, South Dakota, Nebraska, and Kansas. The cold wave pushed southward, losing steadily in energy, and by the evening of the 6th the temperature had begun to moderate rapidly in the Northwest.

Cattle warnings were again issued on the morning of the 8th to Montana, Wyoming, South Dakota, and western Nebraska, in advance of another storm which was approaching from the Plateau region and moving directly eastward over the middle States with increasing intensity; and on the 9th heavy snow warnings were sent to eastern Minnesota and western and northern Wisconsin points.

The various advices were justified for the most part, although the cold-wave warnings in the eastern portion of the district failed of technical verification. It is not known, however, what benefits were directly due to the warnings.

No other warnings were issued during the balance of the month, the period lying between the cold wave and frost warning seasons. One rather severe storm, accompanied by extensive precipitation and strong shifting winds, passed eastward of the central portion of the district at the close of the second week, and two disturbances later skirted the western and southern portions of the district; otherwise, the weather was uneventful.—*H. J. Cox, District Forecaster.*

Denver forecast district.—Although several low-pressure areas of considerable depth moved eastward across the district, no severe weather followed in the wake of the depressions. Low temperatures were of short duration; in fact, the month was markedby a persistency of temperatures much above the seasonal average.

On the morning of the 4th low pressure prevailed from southern Nevada northeastward to Minnesota, with the greatest barometric depression in northern Wyoming. During the next 24 hours the front of the high pressure that was developing in the distant north moved southward to northeastern Wyoming, while the long axis of the low moved a corresponding distance southward. Cold-wave and live-stock warnings for eastern Colorado were issued on the 4th and repeated on the morning of the 5th. Further progress of the anticyclone southward was slow, and while sharp falls occurred in eastern Colorado no very low temperatures were reached. Several other depressions of marked energy moved eastward across the district, but no other cold-wave and live-stock warnings were issued or needed.—*Fredk. H. Brandenburg, District Forecaster.*

New Orleans, La., forecast district.—Storm warnings were not needed and no storm warnings were issued. However, on the 8th and 13th, for brief periods near the time of highest daily temperature, southeast winds exceeding the verifying velocity occurred at Corpus Christi. The cyclonic areas in these instances were central far inland and without marked barometric gradients in southern Texas.

The weather was free from severe cold waves; and temperatures, for the most part, were mild for the season, furthering early development of vegetation and necessitating frost warnings earlier than is usual in the northern portion of the district. By the close of the month these warnings were called for practically throughout the district.

On the 4th a depression of considerable extent, but moderate intensity, extended from the Lakes Region to the central Rocky Mountain States; and a moderate HIGH was moving southward. A cold-wave warning was issued the night of the 4th for the Texas Panhandle and was extended the next morning over Oklahoma. The warning was verified over a considerable portion of Oklahoma. A considerable drop in temperature occurred in the Texas Panhandle, but not as great as was expected, due to continued low presure over the southern Plateau States and weakening of the HIGH.

With a deep LOW over extreme eastern Nebraska and a HIGH over central Canada, cold-wave warnings were issued on the morning of the 9th for Oklahoma and northwestern Arkansas and were verified.

As mild weather had preceded the cold waves of the 5th–6th and the 10th, stockmen in the affected areas were given timely warning of the sudden changes that occurred.

Warnings issued for freezing temperature and frosts were mainly for areas in the northern portion of the district and were mostly verified. Such warnings were issued on the 1st, 4th, 6th, 9th, 10th, 14th, 15th, 16th, 21st, 22d, 23d, 24th, 28th, 29th, and 30th. On the 17th frost occurred in northwestern Louisiana, of which warning was given. The freeze in the Texas Panhandle and portions of Oklahoma on the 6th was predicated 48 hours in advance.

Fire-weather warnings were issued for the forested areas of Oklahoma on the 5th, 8th, 11th, 13th, and 18th, and of Arkansas on the 11th, 13th and 28th. Conditions occurred as forecast except that the wind velocity did not increase on the 19th, due to diminishing intensity of the northwestern LOW on which the warning was based. On the 13th fair weather was successfully predicted for the following "three or four days" in the messages sent to the forest supervisors.—*R. A. Dyke, Assistant Forecaster.*

San Francisco, Cal., forecast district.—March, 1918, like the preceding month, was one of generous rainfall and seasonable temperature. The weather was not unusually stormy for the season and there was no interruption of transportation. Rain continued with but little interruption in Washington and more than the average frequency in other sections of this district, but no excessive daily amounts were reported. There were three well-marked rainy periods in California, from the 6th to the 8th, inclusive, 11th and 12th, and 18th to 20th, inclusive, and while the seasonal rainfall is still below the normal in the northern portion of the State, the drought conditions have been entirely removed.

Frosts occurred on several occasions in northern California, but in every instance they followed immediately after rainy weather and little or no damage resulted.

Storm warnings were ordered as follows: 10th, on the California coast; 12th, from Port Harford to San Diego; 14th, Washington and Oregon coasts; 19th, from the Columbia River north; 21st and 24th, Washington and Oregon coasts. In most cases the hoists were verified.

No live-stock warnings were issued nor was there occasion for them.

The frosts in the Sacramento valley on the morning of the 4th were without warnings in the preceding morning, but were covered by warnings issued on the night of the 3d. A low area off the Washington coast on the morning of the 3d moved rapidly eastward and was followed by a high from the ocean, causing rapidly clearing weather during the afternoon. This movement was not indicated on the morning charts. Also the frost on the morning of the 13th, in the same section, was not forecast. A depression over southern Nevada moved rapidly east during the night of the 12th–13th and was followed by a slight rise in pressure along the California coast causing the weather to clear by morning with a sharp fall in temperature and heavy frost. The warning issued on the morning of the 13th for killing frosts in California was a failure because the high area off the California coast that morning moved rapidly northeastward during the day and night to the northern Plateau region, giving northeast winds and the dynamic effect prevented the expected fall in temperature in California. The frost in the Sacramento valley on the morning of the 27th was without warnings. On the evening of the 26th a depression was central in southern Nevada and cloudy and rainy weather prevailed over northern California, but by the morning of the 27th the depression had moved northeastward to Wyoming and was followed by a slight rise in pressure along the coast, causing fair weather in the Sacramento valley with light to heavy frosts. Warnings were issued in the morning for heavy frosts in northern California on the morning of the 28th, but the high area moved very rapidly eastward and by the morning of the 28th was giving northeasterly winds and slightly warmer weather where frosts had been expected.

These failures were entirely due to rapid barometric changes which were not indicated on the charts.—*G. H. Willson, District Forecaster.*

SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, MARCH, 1918.

By ALFRED J. HENRY, Meteorologist.

[Dated: River and Flood Division, Weather Bureau, Apr. 30, 1918.]

ICE.

On February 28 the ice had passed out of the great majority of streams. The ice broke up and passed out of the Missouri River from Sioux City, Iowa, to the headwaters during the second and third decades of the month. There was practically no damage. On the upper Mississippi likewise the ice went out without gorging.

The breaking up of the ice in Michigan rivers was finally accomplished in March, although the rivers had reached flood stage with an unbroken ice cover in February.[1] The official in charge of the Saginaw, Mich., Weather Bureau Office reports that the Saginaw River rose to 1.6 above flood stage before the ice sheet broke up. There was no gorging of consequence, although damages to cellars and business property in the Grand Rapids district along the river in February and March by overflow water is estimated as follows: Buildings, including factories, $36,450; crops, $700; suspension of business, $82,500. Value of warnings, $25,450. In the Saginaw, Mich., district property loss was about $56,500 and loss due to suspension of business $40,000. In New England the usual heavy ice formed and passed off without damage. In northern New York ice began to break up and go out in February. A gorge formed below Schenectady on the Mohawk River. Fortunately the absence of rainfall during the last half of March prevented serious damage to Schenectady property. Local ice gorges in the Hudson in the neighborhood of Albany caused some loss and inconvenience but no serious loss. The property loss in the Mohawk valley due to ice gorges is estimated at $3,500.

River ice in the Susquehanna in southeastern New York was unusually heavy; it began to break up as early as February 28, when long shallow gorges were formed in the vicinity of Binghampton. These passed out on March 14-17 without serious damage.

RAIN FLOODS.

The most important flood of the month was in the Ohio between Pittsburgh, Pa., and the lower reaches of the river. See Table 3. This flood was the result of a single rainstorm which passed over the watershed from west to east on the 13th-14th. The rains over the upper watershed started a flood in both tributaries of the Ohio in western Pennsylvania and a moderate flood wave passed downstream, decreasing in volume as it reached the lower river and not causing even a flood stage at Cairo, Ill., at the mouth of the river.

The property loss due to this flood in the Pittsburgh district was mainly due to flooded cellars and suspension of business; it is estimated that the total loss was $25,000.

[1] Reported by Meteorologist Chas. F. Schneider.

In the Cincinnati district damage of about $100,000 was sustained mainly in the Kanawha, Elk, and Gauley valleys.

A moderate flood occurred in the James River of Virginia due to the same rainstorm that caused the Ohio flood. The damage at Richmond, Va., amounted to about $1,000. A sudden flood occurred on the Guadalupe River of Texas on the 29th, due to heavy rains over a limited area. The loss to crops is estimated at $200; live stock, $600; total, $800.

The usual tabular matter follows:

TABLE 1.—*Flood stages in Atlantic drainage during March, 1918.*

River and station.	Flood stage.	Above flood stages—dates.		Crest.	
		From—	To—	Stage.	Date.
	Feet.			Feet.	
Connecticut: White River Junction, Vt	13	23	23	13.0	23
Mohawk: Schenectady, N. Y	15	23	23	15.9	23
Susquehanna:					
Bainbridge, N. Y	11	(†)	3	16.9	*27
		7	8	14.4	7
	....	14	15	12.8	14
Harrisburg, Pa	17	....	....	15.8	16
Towanda, Pa	16	15	15	16.9	15
Wilkes-Barre, Pa	20	15	16	23.0	15
Susquehanna, West Branch (Pine Creek): Waterville, Pa	13	....	....	11.8	14
Chenango: Sherburne, N. Y	8	(†)	4	9.5	*26-27
		7	7	8.6	7
Chemung: Corning, N. Y	16	14	14	18.8	14
James:					
Buchanan, Va	15	14	14	17.0	14
Columbia, Va	18	15	15	21.4	15
Richmond, Va	10	....	....	9.6	16

* February. † Continued from February.

TABLE 2.—*Flood stages in Great Lakes drainage during March, 1918.*

River and station.	Flood stage.	Above flood stages—dates.		Crest.	
		From—	To—	Stage.	Date.
	Feet.			Feet.	
Maumee: Fort Wayne, Ind	15	....	....	13.5	15
Shiawassee: Chesaning, Mich	17	....	....	14.6	18
Flint: Fosters, Mich	18	15	15	18.0	15
Saginaw: Saginaw, Mich	19	16	29	23.5	22
Tittabawassee:					
Midland, Mich	12	19	25	18.0	21
Paines, Mich	20	....	....	18.7	21
Pine: Alma, Mich	7	15	16	7.4	16
		18	24	8.9	21
Chippewa: Mount Pleasant, Mich	11	20	25	12.9	21-22
Cass: Vassar, Mich	14	14	24	17.0	21
Grand:					
Eaton Rapids, Mich	6	(†)	3	7.0	*28
		14	18	9.0	14
Lansing, Mich	11	14	18	16.7	15
Grand Ledge, Mich	6	1	7	10.5	5
		14	20	11.0	15
Portland, Mich	12	....	....	11.5	16
Ionia, Mich	21	1	1	21.0	1
		15	20	24.1	17
Lowell, Mich	15	1	2	15.2	1
		15	21	18.1	17
Grand Rapids, Mich	11	(†)	7	15.8	*21
		14	24	16.4	18
Red Cedar: East Lansing, Mich	8	1	1	8.8	1
		13	19	12.0	15

* February. † Continued from February.

TABLE 3.—*Flood stages in Mississippi drainage during March, 1918.*

River and station.	Flood stage.	Above flood stages—dates. From—	Above flood stages—dates. To—	Crest. Stage.	Crest. Date.
Ohio:	*Feet.*			*Feet.*	
Pittsburgh, Pa	22	15	16	25.8	15
Davis Island Dam (Bellevue, Pa.)	25			24.9	14
Dam No. 2 (Coraopolis, Pa.)	26	15	15	26.6	15
Beaver Dam (Beaver, Pa.)	30	15	16	36.5	15
Dam No. 12 (near Wheeling, W. Va.)	36			34.8	16
Dam No. 13 (near Wheeling, W. Va.)	43			39.1	16
St. Marys, W. Va	38			34.4	17
Marietta, Ohio	33	17	17	34.0	17
Parkersburg, W. Va	36			35.3	17
Dam No. 19 (near Tallman, W. Va	39			35.9	17
Dam No. 22 (near Ravenswood, W. Va.)	42			39.4	17
Point Pleasant, W. Va	40	14	18	46.9	15
Dam No. 26 (Hogsett, W. Va.)	50			49.8	15
Dam No. 28 (near Huntington, W. Va.)	50			48.2	16
Dam No. 29 (Normal, Ky.)	50	15	16	52.3	16
Portsmouth, Ohio	50	16	17	52.1	16
Maysville, Ky	50	16	17	50.6	16-17
Concinnati, Ohio	50	17	18	51.5	17
Madison, Ind	46			41.7	18
Cloverport, Ky	40	20	21	40.5	20
Henderson, Ky	33	(†)	3	37.8	*16-18
		20	24	35.1	22
Mount Vernon, Ind	35	(†)	2	39.0	*18
		21	23	35.6	22-23
Evansville, Ind	35	(†)	2	39.8	*17
		20	24	37.2	22
Shawneetown, Ills	35	(†)	4	40.2	*25
		23	23	35.0	23
Allegheny:					
Olean, N. Y	12	14	15	13.2	15
Franklin, Pa	15	15	15	16.0	15
Parkers Landing, Pa	18	15	15	19.0	15
Mosgrove, Pa	20	15	15	21.7	15
Freeport, Pa	22	15	15	24.5	15
Dam No. 3 (Springdale, Pa.)	27	15	15	27.0	15
Herrs Island Dam (Pittsburgh, Pa.)	22	15	16	27.2	15
Clarion: Clarion, Pa	12	15	15	12.2	15
Monongahela:					
Fairmont, W. Va	25	14	15	30.4	14
Greensboro, Pa	20	14	15	30.6	14
Lock No. 4, Pa	31	14	15	37.8	14
Cheat: Rowlesburg, W. Va	12	13	14	13.6	13
Shenango: Sharon, Pa	9	14	16	13.3	15
Mahoning: Youngstown, Ohio	7			6.9	15
Little Kanawha:					
Glenville, W. Va	22	13	14	32.9	13
Creston, W. Va	20	14	15	32.0	14
Muskingum: Marietta, Ohio	36			35.7	17
Tuscarawas: Norris Point, Ohio	8	2	2	8.7	2
Hocking: Athens, Ohio	17	14	14	17.4	14
Scioto:					
Larue, Ohio	11			10.6	2
Circleville, Ohio	7	15	15	7.8	15
Kanawha:					
Kanawha Falls, W. Va	25	13	13	25.4	13
Charleston, W. Va	30	14	15	36.1	14
Greenbrier: Renick, W. Va	17	14	14	20.4	14
Elk:					
Sutton, W. Va	30	(*)	13	40.0	13
Clay, W. Va	18	13	14	32.4	14
Wisconsin: Knowlton, Wis	12	21	23	12.9	22
Illinois:					
Peru, Ill	14	(†)	(††)	21.8	*16
Henry, Ill	7	(†)	(**)	13.7	*18-19
Peoria, Ill	16	(†)	25	19.7	*20
Havana, Ill	14	(†)	24	15.5	*24-27
Beardstown, Ill	12	(†)	(**)	15.7	*28
Pearl, Ill	12			11.8	1-9
Mississippi:					
New Madrid, Mo	34			30.6	1
Arkansas City, Ark	42			30.8	5-7
Missouri Basin.					
Missouri:					
Ree, N. Dak	12	24	24	12.0	24
Bismarck, N. Dak	14			13.6	23
Running Water, S. Dak	16			14.8	27
Huron, S. Dak	9			8.7	27
Omaha, Nebr	19			17.3	31
Blair, Nebr	15	31	(**)	15.9	31
Yellowstone: Glendive, Mont	17	19	19	17.1	19
Arkansas Basin.					
Cache: Jelks, Ark	9			8.6	1-2

* February.
† Continued from February.
†† No reading after March 26.
** Continued into April.

TABLE 4.—*Flood stages in other basins during March, 1918.*

River and station.	Flood stage.	Above flood stages—dates. From—	Above flood stages—dates. To—	Crest. Stage.	Crest. Date.
West Gulf drainage.					
Guadalupe: Victoria, Tex	*Feet.* 16	29	29	*Feet.* 17.8	29
Pacific drainage.					
Salt River: Phoenix, Ariz	5	9	9	8.9	9
		13	13	8.0	13
Mormon Slough: Bellota, Cal	20			18.5	12

MEAN LAKE LEVELS DURING MARCH, 1918.

By UNITED STATES LAKE SURVEY.

[Dated: Detroit, Mich., Apr. 5, 1918.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.* Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during March, 1918:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sealevel at New York	601.61	581.06	572.25	246.61
Above or below—				
Mean stage of February, 1918	−0.10	+0.24	+0.58	+0.63
Mean stage of March, 1917	−0.71	+0.62	+0.67	+1.44
Average stage for March last 10 years	+0.01	+1.18	+0.53	+0.89
Highest recorded March stage	−0.67	−1.89	−1.60	−1.20
Lowest recorded March stage	+0.95	+1.95	+1.42	+2.31
Average relation of the March level to—				
February level	−0.2	±0.0	+0.1	+0.2
April level	±0.0	−0.3	−0.7	−0.7

* Lake St. Clair's level: In March, 574.61 feet.

MEAN LAKE LEVELS DURING FEBRUARY, 1918.[1]

By UNITED STATES LAKE SURVEY.

[Dated: Detroit, Mich., Mar. 5, 1918.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.* Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during February, 1918:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sealevel at New York	601.71	580.82	571.67	245.98
Above or below—				
Mean stage of January, 1918	−0.22	+0.06	−0.21	−0.09
Mean stage of February, 1917	−0.68	+0.44	+0.32	+0.90
Average stage for February last 10 years	−0.07	+0.98	+0.09	+0.47
Highest recorded February stage	−0.77	−1.90	−2.08	−1.69
Lowest recorded February stage	+0.95	+1.66	+1.04	+2.15
Average relation of the February level to—				
January level	−0.2	±0.0	±0.0	+0.2
March level	+0.2	±0.0	−0.1	−0.2

[1] This report received too late for February issue of the REVIEW.
* Lake St. Clair's level: In February, 574.54 feet.

SECTION V.—SEISMOLOGY.

SEISMOLOGICAL REPORTS FOR MARCH, 1918.

W. J. HUMPHREYS, Professor in Charge.

[Dated: Seismological Investigations, Weather Bureau, May 2, 1918.]

TABLE 1.—*Noninstrumental earthquake reports, March, 1918.*

Date.	Approximate time, Greenwich Civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
		CALIFORNIA.								
1918.	H. m.		° ′	° ′			*Seconds.*			
Mar. 1	2 35	Bishop (18 miles W.)	37 22	118 47	3	1	2	No	Gradual trembling	William Barth.
Mar. 1	2 35	Round Valley (6 miles W.)	37 25	118 46	4	1	15	Yes	Rumbling and trembling	Glen H. Crow.
3	4 30	Eureka	40 48	124 11	3	1	Short.	No	Trembling	G. E. Kammerer.
5 6	11 00 16 30 16 15	Cahuilla	33 32	116 45	4	1		No	Water level in well fell 2 feet and rose several feet in well 3 miles north during following 48 hours and had not returned to former levels up to Apr. 8.	Hartwell W. Gardner.
6	18 25	Arroyo Seco	34 07	118 11	4	1		No		W. D. Marx.
		Hollywood	34 06	118 20	5	1		No		Los Angeles Times.
		Los Angeles	34 03	118 15	5	1		No		U. S. Weather Bureau.
		Santa Monica	34 02	118 30	3	1	4	No	Twisting movement	W. F. Bates.
		Venice	33 58	118 28	5	1	7	Yes	Rumbling like an explosion, rocking NE.-SW.	Dr. Jas. T. Brown.
8	12 30	Ocean Park	34 02	118 30	4	2	Few.	Yes	Rumbling and bumping	A. W. Pugh.
		Venice	33 58	118 28	5	1	2	Yes	Rumbling and bumping	A. H. Anthony.
12	10 30	Downieville	39 34	120 50	8	1		No	A few chimneys toppled over during these two 'quakes.	San Francisco Chronicle.
12	12 30	Downieville	39 34	120 50	8	1		No		
21	23 25	Barrett (6 miles N.)	32 42	116 41	5	1	3	Yes	Loud rumbling and trembling	L. Watts.
30	16 05	Cahuilla	33 32	116 45	6	1		No		Hartwell W. Gardner.
		WASHINGTON.								
2	00 08	Walla Walla	46 02	118 20	3	2	1	No	Abrupt bumping N.-S	C. C. Garrett.
		LATE REPORT.								
		MICHIGAN.								
Feb. 22	Early morning.	Morrice	42 51	84 11	4	1	1	Yes	Abrupt bump. Frost crack 150 feet long, 4 feet deep. Numerous diverging cracks.	Mr. and Mrs. Buck.

TABLE 2.—*Instrumental seismological reports, March, 1918.*

[Time used: Mean Greenwich, midnight to midnight. Nomenclature: International.]

[For significance of symbols see REVIEW for January, 1918, p. 34.]

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.

Alaska. *Sitka.* *Magnetic Observatory.* U. S. Coast and Geodetic Survey. J. W. Green.

Lat. 57° 03′ 00″ N.; long., 135° 30′ 06″ W. Elevation, 15.2 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: $\begin{cases} E & 10 & 16 \\ N & 10 & 15 \end{cases}$ (V, T_0)

(No earthquake recorded during March, 1918.)

Arizona. *Tucson.* *Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. P. Ulrich.

Lat., 32° 14′ 48″ N.; long., 110° 50′ 06″ W. Elevation, 769.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: $\begin{cases} E & 10 & 19 \\ N & 10 & 19 \end{cases}$ (V, T_0)

(No earthquake recorded during March, 1918.)

California. *Berkeley.* *University of California.*

Lat., 37° 52′ 16″ N.; long., 122° 15′ 37″ W. Elevation, 85.4 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Mount Hamilton.* *Lick Observatory.*

Lat., 37° 20′ 24″ N.; long., 121° 38′ 34″ W. Elevation, 1,281.7 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Point Loma.* *Raja Yoga Academy.* F. J. Dick.

Lat., 32° 43′ 03″ N.; long., 117° 15′ 10″ W. Elevation, 91.4 meters.

Instrument: Two-component, C. D. West seismoscope.

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Mar. 5					100	100		Tremors during 24 hours preceding 15h.

TABLE 2.—*Instrumental seismological reports, March, 1918*—Continued.

California. *Santa Clara. University of Santa Clara.* J. S. Ricard, S. J.

Lat., 37° 26′ 36″ N.; long., 121° 57′ 03″ W. Elevation, 27.43 meters.

(See record of the Seismographic Station, University of Santa Clara.)

Colorado. *Denver. Sacred Heart College.* Earthquake Station. A. W. Forstall, S. J.

Lat., 39° 40′ 36″ N.; long., 104° 56′ 54″ W. Elevation, 1,655 meters.

Instrument: Wiechert 80 kg.; astatic, horizontal pendulum.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			H. m. s.	Sec.	μ	μ	km.	
Mar. 10								Activity and thickening of pen marks at intervals during day.
14 to 22								Seismograph clock out of repair. Instrument not working.
22 to 31								No 'quakes recorded.

District of Columbia. *Washington. U. S. Weather Bureau.*

Lat., 38° 54′ 12″ N.; long., 77° 08′ 03″ W. Elevation, 21 meters.

Instrument: Marvin vertical pendulum, undamped. Mechanical registration.

Instrumental constants.. V 110, T_0 6.4

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			H. m. s.	Sec.	μ	μ	km.	
Mar. 16		P	13 46 20					
		Prep[1]	13 47 00					
		S	13 54 33					
		Srep[1]	13 55 15					
		Srep[2]	13 56 55					
		eL	14 08 ..					
		L	14 13 30	20				
		F	14 25 ..					
19		eL	6 55 30					
		F	7 20 ..					
21		e	17 06 ..					
		eL	17 10 25					
		F	17 40 ..					

District of Columbia. *Washington. Georgetown University.* F. A. Tondorf, S. J.

Lat., 38° 54′ 25″ N.; long., 77° 04′ 24″ W. Elevation, 42.4 meters. Subsoil: Decayed diorite.

Instruments: Wiechert 200 kg. astatic horizontal pendulums, 80 kg. vertical.

Instrumental constants	V	T_0	ε
E	165	5.4	0
N	143	5.2	0
Z	80	3.0	0

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			H. m. s.	Sec.	μ	μ	km.	
Mar. 16								Quake lost between 13h. and 14h. while changing sheets.
19		L_E	6 57 ..					Periods variable. No trace on N-S. All seismographs show alike.
			7 18 ..					
21		e	3 53 59					Heavy microseisms.
		eL_N	4 39 ..					
21		e_N	17 05 19					Heavy microseisms. Gram difficult. L shows on vertical. No other phases apparent.
		e_E	17 05 21					
		S_N?	17 10 51					
		eL_N?	17 14 07					
		eL_E?	17 14 10					
		L_N	17 19 04	13				
		F	17 36 ..					

Hawaii. *Honolulu. Magnetic Observatory.* U. S. Coast and Geodetic Survey. Frank Neumann.

Lat., 21° 19′ 12″ N.; long., 158° 03′ 48″ W. Elevation, 15.2 meters.

Instrument: Milne seismograph of the Seismological Committee of the British Association.

Instrumental constant.. T_0 18.6

(No earthquake recorded during March, 1918.)

Kansas. *Lawrence. University of Kansas.* Department of Physics and Astronomy. F. E. Kester.

Lat., 38° 57′ 30″ N.; long., 95° 14′58″ W. Elevation, 301.1 meters.

Instrument: Wiechert.

Instrumental constants	V	T_0	ε
E	177	3.4	4.0
N	205	3.4	3.8

(Report for March, 1918, not received.)

Maryland. *Cheltenham. Magnetic Observatory.* U. S. Coast and Geodetic Survey. George Hartnell.

Lat., 38° 41′ 00″ N.; long., 76° 50′ 30″ W. Elevation, 71.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants	V	T_0
E	10	32
N	10	27

(No earthquake recorded during March, 1918.)

Massachusetts. *Cambridge. Harvard University Seismographic Station.* J. B. Woodworth.

Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation: Glacial sand over clay.

Instruments: Two Bosch-Omori 100 kg. horizontal pendulums (mechanical registration).

Instrumental constants	V	T_0	ε
E	80	23	0
N	50	25	4.1

(Report for March, 1918, not received.)

Missouri. *Saint Louis. St. Louis University.* Geophysical Observatory. J. B. Goesse, S. J.

Lat., 38° 38′ 15″ N.; long., 90° 13′ 58″ W. Elevation, 160.4 meters. Foundation: 12 feet of tough clay over limestone of Mississippi system, about 300 feet thick.

Instruments: Wiechert, 80 kg. astatic, horizontal pendulum.

Instrumental constants.. V 80, T_0 7, ε 5:1

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			H. m. s.	Sec.	μ	μ	km.	
Mar. 4								Heavy microseisms. No other disturbances recorded during the month.
5								
21								

New York. *Buffalo. Canisius College.* John A. Curtin, S. J.

Lat., 42° 53′ 02″ N.; long., 78° 52′ 40″ W. Elevation, 190.5 meters.

Instrument: Wiechert 80 kg. horizontal.

Instrumental constants.. V 80, T_0 7, ε 5:1

(Report for March, 1918, not received.)

New York. *Ithaca. Cornell University.* Heinrich Ries.

Lat., 42° 26′ 58″ N.; long., 76° 29′ 09″ W. Elevation, 242.6 meters.

Instruments: Two Bosch-Omori, 25 kg., horizontal pendulums (mechanical registration.)

Instrumental constants	V	T_0	ε
E	13	22	4:1
N	14	25	4:1

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			H. m. s.	Sec.	μ	μ	km.	
Mar. 21		e_N	17 11 13	8				See Table 3 for Feb. report.
		F_N	17 46 ..					

New York. *Fordham. Fordham University.* W. C. Repetti, S. J.

Lat., 40° 51′ 47″ N.; long., 73° 53′ 08″ W. Elevation, 23.0 meters.

Instrument: Wiechert, 80 kg.

Instrumental constants	V	T_0	ε
E	72	6.6	1.5:1
N	72	7.1	3.8:1

(No earthquake recorded during March, 1918.)

TABLE 2.—*Instrumental seismological reports, March, 1918*—Continued.

Panama Canal Zone. *Balboa Heights.* Isthmian Canal Commission.

Lat., 8° 57′ 39″ N.; long., 79° 33′ 29″ W. Elevation, 27.6 meters.
Instruments: Two Bosch-Omori, 100 kg.

Instrumental constants.. V 35 T_0 20

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Mar. 11	....	P.....	16 25 44	....	....	....	386	Direction?
		L_E....	16 25 32	20	*22,000	....	....	
		M_E....	16 25 40	....	....	....	....	
		L_N....	16 26 32	20	....	*18,000	....	
		M_N....	16 26 44	....	....	....	....	
		F_E....	16 45 ..	....	....	....	....	
		F_N....	16 46 ..	....	....	....	....	

*Trace amplitude.

Porto Rico. *Vieques. Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. L. Adams.

Lat., 18° 08′ 48″ N.; long., 65° 26′ 54″ W. Elevation, 19.8 meters.
Instruments: Two Bosch-Omori.

Instrumental constants.. {E V 10 T_0 18; N V 10 T_0 19

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Mar. 13	....	e......	14 49 55	....	....	....	....	
		M.....	14 50 43	2	10	10	....	
		F.....	14 54 ..	....	....	....	....	

Vermont. *Northfield. U. S. Weather Bureau.* Wm. A. Shaw.

Lat., 44° 10′ N.; long., 72° 41′ W. Elevation, 256 meters.
Instruments: Two Bosch-Omori, mechanical registration.

Instrumental constants.. {E V 10 T_0 15; N V 10 T_0 16

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Mar. 16	....	e......	13 48 ..	....	....	....	....	
		Srep? .	13 55 36	....	....	....	....	
		L.....	14 04 ..	12	....	....	....	
		F.....	14 20 ..	....	....	....	....	

Canada. *Ottawa. Dominion Astronomical Observatory.* Earthquake Station. Otto Klotz.

Lat., 45° 23′ 38″ N.; long., 75° 42′ 57″ W. Elevation, 83 meters.

Instruments: Two Bosch photographic horizontal pendulums, one Spindler & Hoy 80 kg. vertical seismograph.

Instrumental constants: V 120 T_0 26

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Mar. 11	....	eL?...	16 44 ..	22	....	....	....	Heavy microseisms on both components.
16	....	O.....	13 40 31	....	....	....	3,380	Heavy microseisms on both components.
		P.....	13 47 02	....	....	....	....	
		Prep[1] .	13 47 45	....	....	....	....	
		Prep[2] .	13 48 00	....	....	....	....	
		S......	13 52 11	....	....	....	....	
		eL....	13 55 51	14	....	....	....	
		L.....	14 04 ..	10	....	....	....	
		F.....	14 30 ..	....	....	....	....	
19	....	eL....	6 55 to	20	....	....	....	
		....	7 05 ..	18	....	....	....	
		L.....	7 09 ..	17	....	....	....	
		L.....	7 16 ..	16	....	....	....	
		L.....	7 23 ..	16	....	....	....	
		L.....	7 28 ..	16	....	....	....	
		F.....	7 40 ..	....	....	....	....	
21	....	*Prep*[1] .	?3 49 20	....	....	....	6,000	△ approximate.
		S......	3 54 44	....	....	....	....	
		Srep[1] .	3 58 51	....	....	....	....	
		eL....	†4 03 30	16	....	....	....	
		F.....	4 15 ..	....	....	....	....	
21	....	e?.....	†16 39 30	....	....	....	....	
		e......	†16 47 06	....	....	....	....	
21	....	e......	17 06 43	5	....	....	....	
		eS?....	17 12 04	8	....	....	....	
		e......	†17 16 48	Irreg..	....	....	....	
		eL....	17 20 ..	18	....	....	....	
		L.....	17 32 ..	9	....	....	....	
		F.....	17 55 ..	....	....	....	....	
22	....	eL....	† 6 30 30	....	....	....	....	
		L.....	6 40 ..	18	....	....	....	
		F.....	6 50 ..	....	....	....	....	

† Original time given in tenths of a minute.

Canada. *Toronto. Dominion Meteorological Service.*

Lat., 43° 40′01″ N.; long., 79° 23′ 54″ W. Elevation, 113.7 meters. Subsoil: Sand and clay.

Instrument: Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation: 1 mm. swing of boom=0.50″.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Mar. 11	....	L.....	†16 38 00	....	....	....	....	Microseisms going on.
		L.....	16 43 24	....	....	....	....	
		L.....	16 48 36	....	*200	....	....	
		F.....	16 59 18	....	....	....	....	
16	....	L.....	13 53 06	....	....	....	....	
		iL....	13 55 48	....	....	....	....	
		M.....	13 56 42	....	*300	....	....	
		F.....	14 30 36	....	....	....	....	
19	....	eL....	6 57 48	....	....	....	....	Marked gradual thickening. Markings at 6[h] 45[m] 42[s] and 6[h] 49[m] 42[s]; may not be seismic.
		M.....	7 02 54	....	*800	....	....	
		F.....	7 32 24	....	....	....	....	
19	....	L.....	7 59 42	....	....	....	....	May not be seismic.
		L.....	8 05 54	....	*50	....	....	
		L.....	8 17 36	....	....	....	....	
20	....	L.....	1 48 12	....	*50	....	....	
		F.....	1 52 12	....	....	....	....	
20	....	L.....	2 06 24	....	*50	....	....	
		F.....	2 11 54	....	....	....	....	
21.	....	L.....	1 11 06	....	....	....	....	May not be seismic.
		M.....	1 12 18	....	*200	....	....	
		F.....	1 16 18	....	....	....	....	
21	....	L.....	4 01 36	....	....	....	....	May not be seismic.
		L.....	4 10 12	....	*100	....	....	
		F.....	4 21 24	....	....	....	....	
21	....	L.....	16 55 48	....	*50	....	....	
		F.....	17 03 06	....	....	....	....	
21	....	L.....	17 18 36	....	....	....	....	Gradual thickening.
		L.....	17 20 36	....	*200	....	....	
		M.....	17 26 42	....	....	....	....	Marked microseisms during night of 21st and morning of 22d.
		F.....	17 35 48	....	....	....	....	
22	....	iL.....	6 32 36	....	*200	....	....	
		M.....	6 32 48	....	....	....	....	
		F.....	6 41 12	....	....	....	....	
26	....	....	....	....	....	....	....	'Quake lost while changing sheet. Light down at 19[h] 41[m].

* Trace amplitude.
† Original time of all readings given in tenths of a minute.

Canada. *Victoria, B. C. Dominion Meteorological Service.*

Lat., 48° 24′ N.; long., 123° 19′ W. Elevation, 67.7 meters. Subsoil: Rock.

Instrument: Wiechert, vertical; Milne horizontal pendulum, North. In the meridian

Instrumental constant.. T_0 18. Pillar deviation, 1 mm., swing of boom=0.54″.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1918.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Mar. 16	....	M.....	14 00 00	....	*200	....	....	
19	....	L.....	6 38 51	....	....	....	....	Marked gradual thickening.
		eL....	6 39 24					
		M.....	6 46 43	....	*1,000	....	....	
		F.....	7 19 40	....	....	....	....	
			VERTICAL		A_Z.			
		M	*6 41 30*	*20*	*2*	....	....	
20	....	L.....	1 56 35	....	....	....	....	
		M.....	2 00 28	....	*400	....	....	
		F.....	2 11 21	....	....	....	....	
20	....	....	....	....	....	....	....	No trace from 20[h] 01[m] to 21st, 19[h] 53[m].
22	....	....	....	....	....	....	....	Center line so thick impossible to detect a small 'quake.
26	....	P.....	19 51 41	....	....	....	1,410?	
		L.....	19 54 09	....	....	....	....	
		M.....	19 55 37	....	*700	....	....	
		F.....	20 01 32	....	....	....	....	

* Trace amplitude.

TABLE 3.—*Late reports (instrumental).*

New York. *Ithaca. Cornell University.* Heinrich Ries.

Lat., 42° 26′ 58″ N.; long., 76° 29′ 09″ W. Elevation, 242.6 meters.

Instruments: Two Bosch-Omori, 25 kg., horizontal pendulums (mechanical registration.)

Instrumental constants	V	T_0	ϵ
E	13	22	4:1
N	14	25	4:1

Date.	Character.	Phase.	Time.	Period. T.	Amplitude.		Distance.	Remarks.
					A_E	A_N		
1918.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Feb. 12	....	eL_N...	1 41 20	13	....	....	......	
		F_E....	1 58 ..	....	....	....	......	
12	....	e_E.....	20 20 21	3	....	....	......	
		e_N.....	20 20 29	3	....	....	......	
		eL_N...	20 20 58	14	....	....	......	
		eL_E...	20 23 01	10	....	....	......	
		F.....	20 28 ..	....	....	....	......	
13	....	eL_N...	3 55 17	22	....	....	......	
		F_N....	4 09 ..	....	....	....	......	
Feb. 13	....	e......	6 25 28	....	....	....	......	
		e......	6 27 50	....	....	....	......	
		e......	6 35 30	....	....	....	......	
		e_N.....	6 42 40	40	....	....	......	
		L_N....	6 59 45	35	....	....	......	
		M_N....	7 21 05	16	....	*500	......	
		F.....	8	....	....	....	......	
19	....	eL_N...	17 21 ..	22	....	....	......	
		F_N....	17 48 ..	....	....	....	......	

* Trace amplitude.

SEISMOLOGICAL DISPATCHES.[1]

There were no press reports of seismological or vulcanological disturbances during March, 1918.

[1] Reported by the organizations indicated and collected by the seismological station at Georgetown University, Washington, D. C.

SECTION VI.—BIBLIOGRAPHY.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. FITZHUGH TALMAN, Professor in Charge of Library.

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Annuaire astronomique et météorologique pour 1918, par Camille Flammarion. 54e année. Paris. 1918. 364 p. front. illus. charts. tables. diagrs. 18 cm. [Climatologie de l'année 1916, p. [299]-343.]

Cooper, Alfred J.
Solectrics; a theory explaining the causes of tempests, seismic and volcanic disturbances, and other natural phenomena . . . London. 1917. p. l., [4] 213 [1] p. illus. diagrs. 24 cm.

Eredia, Filippo.
Contributo alla climatologia del Gebel. Firenze. 1917. 20 p. incl. tables. 24½ cm. At head of title: Biblioteca agraria coloniale. (Estratto da "L'agricoltura coloniale," anno 11, 1917.)
Le piene dell'uadi di Derna . . . Roma. 1918. 2 plates. charts. 23½ cm. At head of title: Ministero delle colonie. (Estratto dal Bollettino d'informazioni, anno 5, n. 1-12.)
Tavole ad uso degli osservatorii meteorologici italiani. Roma. 1917. 137 p. l., incl. tables. 26 cm. At head of title: R. Ufficio centrale di meteorologia e geodinamica in Roma.
L'ufficio centrale italiano di meteorologia e geodinamica. Milano. 1918. cover-title, 16 p. illus. 30½ cm. (Estratto da "La scienza per tutti," n. 1, 1° gennaio, 1918. I laboratori scientifici nazionali, 4.)

Helland-Hansen, Bjørn, & Nansen, Fridtjof.
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Mysore. Meteorological dept.
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Report on rainfall registration in Mysore for 1916 . . . Bangalore. 1917. xvii, 53 p. fold. charts. tables. 31½ cm.

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Annual report of the board of control for the fiscal year ending June 30, 1917. Carson City, Nev. 1918. 79 p. illus. tables. 23 cm. (Published by the University of Nevada, Reno, Nev.) [Meteorology, p. 62-66.]

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Sulla ricerca della precipitazioni nell'alta montagna e sul funzionamento dei pluvionivometri totalizzatori nell'alto bacino del Po. Parma. 1918. 27p. plates. 27½ cm. At head of title: Ministero dei lavori pubblici. Reale commissione per gli studi sul regime idraulico del Po. 6.Compartimento del genio civile.

Seeley, Dewey Alsdorf.
The climate of Michigan and its relation to agriculture . . . charts. tables. 23 cm. (Excerpted from Fifty-sixth annual report of the secretary of the state board of agriculture of . . . Michigan and thirtieth annual report of the experiment station from July 1, 1916, to June 30, 1917. Lansing. 1917. p.[679]-715.)

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. FITZHUGH TALMAN, Professor in Charge of Library.

The following titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

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The Guatemala earthquake. p. 201-210.
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Deeley, R. M. Rain, wind, and cyclones. p. 221-245.
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Nature. London. v. 101. 1918.
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Chree, C[harles]. Auroral observations in the Antarctic. p. 114-115. (Apr. 11.) [Abstract of memoir by Mawson.]
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SECTION VII.—WEATHER AND DATA FOR THE MONTH.

THE WEATHER OF MARCH, 1918.

P. C. DAY, Climatologist and Chief of Division.

[Dated: Climatological Division, Weather Bureau, May 1, 1918.]

PRESSURE AND WINDS.

The distribution of the mean atmospheric pressure over the United States and Canada, and the prevailing direction of the winds for March, 1918, are graphically shown on Chart VII, while the means at the several stations, with the departures from the normal, are shown in Tables I and III.

The month opened with pressure considerably above the normal over all the interior portions of the country, but somewhat below in the British Northwest. During the following few days there was a general fall in pressure over most districts and by the 5th pressure well below normal had overspread the interior districts, but it was rising in the far Northwest. No important changes in pressure occurred thereafter until near the end of the first decade when a marked depression appeared in the Middle Plains region and moved rapidly eastward to the Atlantic Coast, followed closely by an extensive high area which likewise moved rapidly to the coast districts.

Early in the second decade low pressure again developed in the Central Western districts and by the middle of the month had passed to the Canadian Maritime Provinces, at which time pressure far above normal was moving into the middle Rocky Mountain and adjacent districts. This area quickly overspread the central and eastern portions of the country, but with diminishing intensity, and by the end of the decade pressure was again below normal over much of the country.

During the last decade of the month pressure changes were not unusual, but there was a general tendency toward high pressure in the Lakes region and over the districts to the southward, until near the close of the month.

The average pressures for the month were above the normal over practically all southern districts and below the normal over most of the far Northern States and in the adjoining portions of Canada, the negative departures being quite large in the Northwest Provinces.

The general pressure distribution favored warm southerly winds over the greater part of the country, the results of which are well illustrated in the chart showing the departures of the mean temperatures of the month from the normal.

TEMPERATURE.

Pleasant weather prevailed in most sections of the country during the greater part of the first week, but early in the second week there was a decided drop in temperature throughout the Central States and lower Lakes region. Somewhat warmer weather followed until near the end of the week, when another fall in temperature occurred but less marked than that during the early part of the week. Generally mild weather prevailed much of the time throughout the remainder of the month, although frosts occurred as far south as Arkansas on the 25th, and in North Carolina during the last few days of the month.

The average temperature for the month was above the normal in practically all portions of the country, the maximum departures exceeding 15° in portions of Minnesota and North Dakota, and in the adjoining Canadian Provinces the excess was even greater. Over most of the principal winter-wheat and corn growing sections, the average temperature was from 6° to 10° above the normal, while farther south in the cotton region the averages were somewhat less. In the extreme northwest and northeast sections there were small areas with mean temperature slightly less than normal.

Maximum temperatures above 90° were observed at points in the Southwest, but they were not higher than usually recorded in March, save in a few instances. While no extremely low temperatures were recorded only the more Southern States were entirely free from freezing temperature at some time during the month. In the more northern districts temperatures were occasionally below zero during the early part of the month, and to the northward of the Lake Superior region temperatures as much as 30° below zero were reported.

No important damage from frost was reported during the month, although some injury to early fruits was indicated in portions of Virginia and in Northern California.

PRECIPITATION.

The month opened with moderate precipitation in eastern Texas, portions of the central Mississippi and Ohio Valleys, the lower Lakes region, and to the eastward. After a few days of fair weather light rain again occurred in the central Mississippi Valley and also in Oklahoma, and the North Pacific States, and toward the latter part of the week there was generally light rain or snow in most northern and eastern sections of the country.

During the early part of the second week general rain or snow, accompanied by high winds, occurred in the Central States and lower Lakes region. Rain, rather heavy at times, prevailed during the second week, and again throughout much of the fourth week, in the Pacific States. During the latter part of the second week there was moderate rain in the Central Valleys, and about the middle of the month precipitation occurred in the Lakes region and to the eastward. A storm moved slowly over the Gulf and South Atlantic States during the next several days, causing unsettled weather throughout that region, and light to moderate rain fell over the Great Plains area during the last few days of the month under the influence of a disturbance that prevailed in the Southwest. The month closed with generally fair weather, except in the coastal portion of the East Gulf States, where there was light rain.

The month as a whole was generally less stormy than is usual for March, especially during the latter half. The total rainfall was slightly over 2 inches in the northwestern and southeastern portions of the cotton area, but in the central portions the rainfall was less than 1 inch, and was less than one-half inch in parts of western Alabama and eastern Mississippi, while in a small area in southeastern Oklahoma it was over 4 inches. Precipitation was considerably less than normal in most of the Southern States, also in Missouri, and slightly deficient in the other principal winter-wheat States. It was likewise deficient in most of the corn-growing districts, and slightly less than normal in the spring-wheat area. The rainfall was somewhat above the normal in Kansas and in southern California it was greater than is usually reported in March, but it was deficient in northern California and Oregon and in eastern Washington. Precipitation was below the normal in Texas, but generally well distributed.

SNOWFALL.

Considerable snow fell during the month in northern New England, in the Adirondacks region of New York, the upper Lakes region, and in much of the West, but by the close of the month the ground east of the Rocky Mountains, except in northern New England, was gener-

ally bare. In the mountains of the West only the higher elevations and protected slopes were covered at the end of the month. As a rule, the accumulated depths were materially less than usual, except in some of the more northern districts. In the mountains of California and adjoining portions of Oregon and Nevada the winter snowfall as a whole was far less than usual and much of that on the ground at the end of the month was received late in the season and therefore in a condition to quickly melt with the advent of warm weather.

RELATIVE HUMIDITY.

The general warmth of the month was prominently reflected in the relative humidity which was nearly everywhere below the normal, the deficiencies being most pronounced at the evening observations and throughout the interior and north Central districts. In portions of the Ohio, Mississippi, and Missouri Valleys the deficiencies ranged from 15 to 20 per cent or more.

GENERAL SUMMARY.

March, 1918, was markedly favorable for outdoor work in nearly all parts of the country. The early advent of winter and the long period during which severe cold held sway permitted of little work usually common to the colder portion of the year. As a result the beginning of spring found this work largely still untouched, but by the end of March, due to favorable weather, much progress had been made and in some sections spring work was farther advanced than usual.

The weather was unusually favorable for wheat and other winter grains, and these crops made marked improvement in most sections, despite their unfavorable conditions at the beginning of the winter.

Good progress was made in preparing for the cotton and corn crops and there was some planting in the more southern districts. The planting of potatoes and truck crops made good progress in southern and central districts. Except for minor damage to fruits, mostly peaches, due to the severe cold during the winter, fruit prospects were generally promising in all parts of the country.

Average accumulated departures for March, 1918.

Districts.	Temperature.			Precipitation.			Cloudiness.		Relative humidity.	
	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure from the normal.	General mean for the current month.	Departure from the normal.
	°F.	°F.	°F.	Ins.	Ins.	Ins.	0-10.		P. ct.	
New England	33.2	+0.4	−10.4	2.13	−1.70	−3.40	5.3	−0.4	72	−3
Middle Atlantic	44.8	+4.8	−3.6	2.81	−0.80	−2.10	4.7	−1.0	67	−6
South Atlantic	59.1	+5.2	+3.1	1.93	−2.40	−6.10	5.1	+0.2	73	−2
Florida Peninsula	73.2	+3.0	+4.1	1.68	−0.60	−3.30	3.3	−0.4	76	−2
East Gulf	63.7	+6.5	+5.8	0.86	−4.90	−6.20	5.1	0.0	70	−5
West Gulf	62.7	+4.8	+0.4	1.26	−1.70	−4.70	5.0	−0.1	68	−4
Ohio Valley and Tennessee	50.2	+6.3	−3.4	1.99	−2.20	−2.80	5.0	−1.1	65	−7
Lower Lakes	37.3	+4.4	−6.2	2.33	−0.30	−0.30	4.8	−1.7	70	−6
Upper Lakes	33.5	+6.2	−5.8	1.31	−0.70	+0.20	4.5	−1.5	74	−4
North Dakota	35.6	+14.7	+14.1	0.48	−0.50	−0.80	5.0	−0.5	70	−8
Upper Mississippi Valley	44.9	+8.9	+0.3	−1.15	−1.30	−2.20	4.6	−1.1	64	−10
Missouri Valley	46.9	+10.8	+6.1	0.92	−1.00	−1.00	4.3	−1.2	60	−10
Northern slope	39.4	+8.6	+7.3	0.72	−0.40	−0.20	5.3	−0.1	62	−6
Middle slope	49.7	+7.2	+4.4	1.46	0.00	+0.10	4.4	−0.3	54	−7
Southern slope	59.0	+5.8	+6.0	0.52	−0.40	−1.20	3.8	−0.5	41	−13
Southern Plateau	52.5	+1.6	+1.9	0.84	+0.30	+0.20	3.8	+0.1	47	+6
Middle Plateau	43.2	+2.3	+3.3	1.60	+0.40	+0.20	4.9	−0.1	56	−2
Northern Plateau	44.3	+4.1	+9.9	1.20	−0.40	−0.30	6.5	+0.7	60	−6
North Pacific	44.8	+0.1	+4.9	4.93	+0.30	+1.10	7.0	+0.4	78	−1
Middle Pacific	51.8	+0.5	+1.7	4.02	−0.20	−3.70	5.4	+0.1	73	−2
South Pacific	57.7	+2.6	+5.3	5.52	+2.90	+3.90	5.0	+0.4	71	0

WEATHER CONDITIONS OVER THE NORTH ATLANTIC OCEAN DURING MARCH, 1917.

The data presented are for March, 1917, and comparison and study of the same should be in connection with those appearing in the REVIEW for that month. Chart IX (XLVI–30) shows for March, 1917, the principal storm track and the averages of pressure, air temperature, water surface temperature, and prevailing direction of the winds at 7 a. m., 75th meridian time (Greenwich mean noon). Notes on the locations and courses of the more severe storms of the month are included in the following general summary.

PRESSURE.

The distribution of the average pressure for the month as shown on Chart IX, differed but little from the normal. The North Atlantic or Azores HIGH, and the Continental HIGH, were both well defined, although the former area was slightly east of its usual position. The Icelandic LOW was also nearly normal in intensity and position, while a second LOW was central about 300 miles northeast of St. John's, N. F.

The pressure changes from day to day were large, as is usually the case in March, and the means of the three decades of the month also differed considerably, as shown in the following table that gives for a number of selected 5° squares the average pressure for each of the three decades of the month as well as the highest and lowest individual readings reported within the respective squares.

Pressure over the North Atlantic Ocean during March, 1917, by 5-degree squares.

Position of 5-degree squares.		Decade means.			Extremes.			
					Highest.		Lowest.	
Latitude.	Longitude.	I.	II.	III.*	Pressure.	Date.	Pressure.	Date.
°	°	Inches.	Inches.	Inches.	Inches.	March.	Inches.	March.
60-65 N	20- 25 W	29.87	29.84	30.01	30.45	31	29.11	5
60-65 N	0- 5 E	29.98	29.78	29.54	30.28	15	28.86	30
55-60 N	35- 40 W	29.50	29.84	30.15	30.40	25,31	28.89	6
50-55 N	55- 60 W	29.93	29.75	30.00	30.40	26	29.20	19
50-55 N	25- 30 W	29.41	29.90	30.25	30.62	25	28.86	6
50-55 N	0- 5 W	29.67	29.99	29.82	30.56	16	29.23	30
45-50 N	65- 70 W	30.14	29.92	29.94	30.41	3	29.40	28
45-50 N	45- 50 W	29.74	29.59	29.97	30.38	27	29.23	7
45-50 N	15- 20 W	29.40	30.12	30.21	30.61	18	28.89	6
40-45 N	55- 60 W	30.11	29.66	29.93	30.50	26	29.18	19
40-45 N	30- 35 W	29.66	29.97	30.30	30.60	25	29.20	8
40-45 N	0- 5 W	29.65	30.20	29.96	30.60	16,18	28.75	7
35-40 N	65- 70 W	30.26	30.00	30.08	30.52	2	29.70	5
35-40 N	20- 25 W	29.86	30.33	30.28	30.50	18,25	29.51	6
35-40 N	5- 10 W	29.90	30.30	30.11	30.40	13,19	29.58	6
30-35 N	55- 60 W	30.25	30.00	30.09	30.43	1	29.80	19
25-30 N	95-100 W	30.14	30.03	30.00	30.40	4	29.78	23
25-30 N	45- 50 W	30.20	30.09	30.09	30.39	3	29.92	29
25-30 N	15- 20 W	30.15	30.29	30.15	30.39	13	29.90	6
20-25 N	30- 35 W	30.15	30.15	30.06	30.33	10	29.93	6
15-20 N	80- 85 W	30.06	30.03	29.99	30.11	7	29.90	21

*Mean of last 11 days of month.

The mean and extreme values presented in the above table are based on the daily pressures determined by interpolation for each square on the MS. daily synoptic charts of the North Atlantic, compiled by the Marine Section of the Weather Bureau.

GALES.

The month taken as a whole was considerably less stormy than usual, as over practically the entire ocean the number of days on which gales were reported was below the normal. They were reported on from 2 to 5 days

over the northern steamer routes, the greatest number occurring over the eastern section.

On the evening of March 3 a LOW (*I* on Chart IX) of slight intensity, was central near Mobile, Ala. Moving in a northeasterly direction, it reached the coast of New Jersey on the morning of the 5th, the barometer at Atlantic City reading 29.60 inches. On the same day a HIGH with a crest of 30.44 inches covered the northwestern part of the Gulf of Mexico. Moderate and strong gales in the Gulf and along the American coast were the result of the steep gradient between these two areas, and one unusual feature was the fact that heavy northerly winds prevailed off the coasts of Alabama and western Florida, where the barometric readings ranged from 30.20 inches to 30.34 inches.

On the 6th the center of LOW *I* was near Halifax, N. S., and a number of vessels in the southerly quadrants encountered westerly gales of from 40 to 55 miles an hour, accompanied by hail. The disturbance then increased its rate of movement toward the North, and on the 7th the center was near latitude 50°, longitude 40°, where the barometer reading was about 29.06 inches. Gales of from 40 to 65 miles an hour still prevailed between the 40th and 50th parallels and the 40th and 60th meridians, while light to moderate winds were reported along the American coast. During the next 24 hours the easterly drift of the LOW was slight, and on the 8th it was central near latitude 48°, longitude 35°. The barometer reading at this point was 29.00 inches and the storm area was of about the same extent as on the previous day. The area of low pressure then began to fill in and on the 9th the center was indeterminate.

From the 3rd to the 6th there was a LOW of varying intensity that occupied the region between the European coast and the 30th meridian, and the 45th and 60th parallels. It moved slightly between these limits from day to day, and attained its greatest intensity on the 4th, when the center was near latitude 50°, longitude 15°, where the pressure was 28.80 inches. Gales of from 40 to 65 miles an hour covered an area extending to the 40th meridian on the West and Azores on the South. On the 5th and 6th this disturbance increased in extent and moderated somewhat in intensity, although strong gales with hail and snow were encountered on both of these dates. On the 7th Bordeaux, France, was near the center of a well developed LOW of 28.73 inches, but no vessel reports were received from the vicinity, and the force of the wind is not shown. From the 11th to the 14th a LOW remained off the coasts of Canada and Newfoundland, drifting slowly eastward; the center on the former date being near St. John's, N. F., and on the latter about 300 miles east of that place. No especially heavy winds were reported from that locality during the period, with the exception of one vessel that on the 12th recorded a southwesterly gale of 55 miles an hour near latitude 42°, longitude 42°.

On the 16th a LOW appeared near latitude 40, longitude 55; two vessels in the western quadrants encountered strong northwesterly gales, while moderate northerly winds were the rule along the American coast. This disturbance moved about 5 degrees toward the east during the next 24 hours, and the winds gradually decreased in force. It continued its slow easterly drift, and on the 18th was central near latitude 40°, longitude 45°, the conditions of wind and weather being about the same as on the previous day.

On the 18th a second area of low pressure covered the greater part of the Province of Quebec, the barometric reading at Chatham being 29.24 inches. Moderate westerly gales were encountered along the 40th parallel, between the 60th and 65th meridians, while in the waters adjacent to the American coast the force of the wind was considerably less. On the 19th this LOW was central in Newfoundland, and had increased considerably in extent, the isobar of 29.2 inches extending from the 40th to 55th parallels, while gales of from 40 to 55 miles an hour occurred over a larger area than the day before. On the 20th the center of this low was about 300 miles northeast of its position on the 19th, the conditions of wind and weather having changed but little. On the 22d a LOW of moderate intensity was central near latitude 40°, longitude 57°. This moved slowly toward the northeast, increasing rapidly in intensity, and on the 23d the center was near latitude 45°, longitude 51°. A number of vessels encountered heavy gales in the southwesterly quadrants, and northwesterly winds of 40 miles an hour extended as far south as the Bermudas. This disturbance curved slightly toward the north, and on the 24th the center was near St. John's, N. F., the weather conditions remaining practically unchanged. One vessel near Hatteras reported a gale of 40 miles an hour, while a number of others in the vicinity experienced only light to moderate winds. From the 25th to 27th the pressure gradients were comparatively weak, and no disturbance of importance appeared on the chart.

On the 28th a moderate LOW covered a portion of the Province of Quebec, but no heavy winds were reported from the vicinity. On the same day a second LOW was apparently central somewhere between Iceland and the Scandinavian Peninsula, although it was impossible to determine the exact position on account of lack of observations. Westerly and northwesterly gales covered quite an extended area between the 54th and 59th parallels, east of the 45th meridian, the maximum velocity being 64 miles an hour. On the 29th this LOW surrounded the Shetland Islands, where the barometer reading was 28.83 inches. Only one vessel report was received from the waters adjacent to the European coast, so it is impossible to state just what the conditions were in the vicinity, although a number of vessels on the steamer lanes between the 20th and 33d meridian encountered strong northwesterly gales, indicating that the storm area was of about the same extent as on the day before. This LOW evidently drifted slowly eastward during the next two days, although so few vessel reports were received from these waters that it was difficult to plot the center accurately, which on the 31st was apparently near Skudesnaes, Norway, where the barometric reading was 29.03 inches. On the 30th the force of the wind was about the same as on two previous days, while by the 31st it had moderated considerably over the steamer lanes. On the 30th a second LOW of slight intensity covered the Gulf of St. Lawrence, and light to moderate winds and fog prevailed off the Banks of Newfoundland. On the 31st this disturbance was central near St. John's N. F., it had increased slightly in intensity, and winds of 40 miles an hour with snow were reported in the southerly quadrants and off the Virginia coast.

TEMPERATURE OF THE AIR.

The average monthly temperature of the air over the ocean was from 2 to 4 degrees above the normal in the waters adjacent to the American coast, and in the northern part of the Gulf of Mexico. Off the European coast the departures were only slightly positive, while over the greater part of the steamer lanes they ranged from 0° to —4°. In the region south of the 40th parallel, between the Bermudas and the Azores, as well as in the southern division of the Gulf of Mexico, the temperature was nearly normal.

The seasonal rise in temperature was quite marked, especially in the northern waters, where the average for the last decade of the month was considerably higher than that of the first. The daily fluctuations were also large, particularly off the coast of Labrador, where the temperature ranged from 16° on the 1st and 5th, to 38° on the 30th.

The following table gives the temperature departures for the month at a number of Canadian and United States Weather Bureau Stations, on the Atlantic and Gulf Coast.

	°F.		°F.
Sydney, C. B. I.	+1.3	Norfolk, Va.	−0.5
Chatham, N. B.	+2.5	Hatteras, N. C.	−0.2
Halifax, N. S.	+1.7	Charleston, S. C.	+2.2
Eastport, Me.	+0.5	Key West, Fla.	+2.4
Portland, Me.	+0.1	Tampa, Fla.	+3.4
Boston, Mass.	+2.2	Mobile, Ala.	+4.3
Nantucket, Mass.	−1.6	New Orleans, La.	+4.1
Block Island, R. I.	0.0	Galveston, Tex.	+1.0
New York, N. Y.	+1.2	Corpus Christi, Tex.	+0.5

WATER SURFACE TEMPERATURES.

The average monthly temperature of the surface water, as compared with the normal, varied considerably over different divisions of the ocean. The water was somewhat warmer than usual off the banks of Newfoundland, although there was a sudden fall in temperature eastward, as the departures ranged from +4 degrees at the 50th meridian to —4 degrees at the 35th. Small positive departures prevailed along the European coast and over the southeastern waters, while in the vicinity of the American coast and in the Gulf of Mexico they were variable, although slightly negative over the greater portion of this territory. The greatest daily fluctuations occurred off the coast of Labrador, where the water temperatures ranged from 23° on the 2d, to 48° on the 16th.

FOG.

Under normal conditions March shows considerable increase in the number of days with fog, as compared with February. For the month under discussion the reverse held true, as fog was only observed on three days off the banks of Newfoundland, where the normal percentage is from 40 to 45, and there was practically none off the American coast and over the steamer lanes.

HAIL AND SNOW.

The most frequent occurrence of hail and snow was in the two 5-degree squares between latitude 55°–60°, longitude 20°–30°, where the former was reported on six days and the latter on five. Both occurred on two days over the mid-section of the steamer routes, while none was recorded in the waters adjacent to the American coasts.

Winds of 50 mis./hr. (22.4 m./sec.) or over, during March, 1918.

Station.	Date.	Velocity.	Direction.	Station.	Date.	Velocity.	Direction.
		Mis./hr.				*Mis./hr.*	
Bismarck, N. Dak.	30	50	nw.	New York, N. Y.	11	52	nw.
Block Island, R. I.	3	62	nw.	Do.	15	76	nw.
Do.	10	60	nw.	Do.	17	58	w.
Do.	11	55	nw.	Norfolk, Va.	10	60	nw.
Do.	15	56	nw.	North Head, Wash.	17	72	se.
Buffalo, N. Y.	2	56	sw.	Do.	21	70	se.
Do.	3	52	nw	Do.	22	50	sw.
Do.	12	60	sw.	Do.	23	58	se.
Do.	16	56	sw.	Do.	24	50	se.
Do.	17	54	sw.	Do.	25	50	s.
Canton, N. Y.	10	60	ne.	Oswego, N. Y.	15	50	ne.
Cheyenne, Wyo.	9	56	nw.	Peoria, Ill.	9	51	sw.
Do.	11	72	w.	Pittsburgh, Pa.	10	59	w.
Do.	13	68	w.	Point Reyes Light, Cal.	10	50	se.
Cincinnati, Ohio.	9	50	sw.	Do.	11	73	se.
Cleveland, Ohio.	10	65	nw.	Do.	17	55	se.
Columbia, Mo.	9	51	sw.	Do.	18	60	s.
Columbus, Ohio.	9	58	w.	Portland, Me.	3	56	nw.
Do.	10	76	nw.	Providence, R. I.	3	65	nw.
Do.	14	52	w.	Do.	15	54	nw.
Concordia, Kans.	9	52	nw.	St. Joseph, Mo.	9	56	nw.
Dayton, Ohio.	9	56	w.	St. Louis, Mo.	9	74	sw.
Do.	10	56	nw.	Sandusky, Ohio.	9	52	sw.
Dodge City, Kans.	9	51	nw.	Do.	10	56	nw.
Elkins, W. Va.	10	54	sw.	Sandy Hook, N. J.	3	56	nw.
Evansville, Ind.	9	58	sw.	Do.	10	71	nw.
Fort Wayne, Ind.	9	55	w.	Do.	15	57	nw.
Green Bay, Wis.	9	62	ne.	Sault Ste. Marie, Mich.	2	60	w.
Hannibal, Mo.	9	58	w.	Springfield, Ill.	9	50	sw.
Houghton, Mich.	2	54	w.	Springfield, Mo.	9	56	w.
Kansas City, Mo.	9	58	w.	Syracuse, N. Y.	3	52	nw.
Keokuk, Iowa.	9	52	sw.	Tatoosh Island, Wash.	17	50	s.
Lincoln, Nebr.	9	58	nw.	Do.	21	56	s.
Louisville, Ky.	9	68	sw.	Do.	24	54	s.
Modena, Utah.	8	52	w.	Terre Haute, Ind.	9	56	sw.
Do.	12	50	sw.	Trenton, N. J.	10	64	nw.
Mount Tamalpais, Cal.	11	58	sw.	Toledo, Ohio.	10	52	nw.
Do.	17	52	s.	Topeka, Kans.	9	58	w.
New Haven, Conn.	3	50	nw.	Wichita, Kans.	9	65	nw.
New York, N. Y.	3	72	nw.				
Do.	10	87	nw.				

CORRECTIONS TO WIND RECORDS AT PORTLAND, ME., AND BALTIMORE, MD., 1915–16.

The following corrections in the wind records at Baltimore, Md., and Portland, Me., are necessary on account of using an anemometer adjusted to record kilometers instead of miles, during portions of months and years indicated.

A.—Corrections to respective issues of Table I.

Baltimore, Md.

Month.	Total movement—		Maximum was—			Maximum should be—		
	Was—	Should be—	Velocity.	Direction.	Date.	Velocity.	Direction.	Date.
1915.	*Miles.*	*Miles.*	*Mis./hr.*			*Mis./hr.*		
February	6,617	4,919	36	s.	18	26	ne.	2
March	6,305	6,096	31	nw.	31	24	n.	8
April	5,722	5,555						
June	5,083	5,018						
July	4,739	4,718						
August	5,033	4,921						
September	4,382	4,289						
October	4,500	4,145						
November	4,651	4,637						
1916.								
January	6,825	5,256	36	n.	14	26	sw.	6
February	5,759	5,746						
April	5,821	5,264	48			30		
May	5,673	5,238	40			25		
June	5,227	5,171						
July	5,292	5,015	25	ne.	28	22	n.	5
September	6,460	4,730	44			27		
October	4,770	4,768						
November	4,800	4,724	29	nw.	30	25	sw.	24
December	4,876	4,827						
1917.								
January	4,227	4,224						
February	5,104	5,102						
March	6,119	5,833	39	sw.	29	28	sw.	5
April	9,125	5,671	44			27		
May	9,393	5,837	43			27		
June	6,349	4,640	48			30		

A.—Corrections to respective issues of Table I—Continued.

Portland, Me.

Month.	Total movement—		Maximum was—			Maximum should be—		
	Was—	Should be—	Velocity.	Direction.	Date.	Velocity.	Direction.	Date.
1916.	*Miles.*	*Miles.*	*Mis./hr.*			*Mis./hr.*		
October	11,497	7,324	63			39		
November	10,533	6,545	61			38		
December	7,821	7,614						
1917.								
January	9,810	6,818	68			42		
February	10,162	6,314	66			41		
March	13,003	8,080	69			43		
April	11,155	6,931	63			39		
May	13,294	8,260	63			39		
June	8,293	5,966	50			31		

B.—Corrections to table of excessive wind velocities; winds of 50 miles/hour (22.4 m./sec.) or over.

Portland, Me.

Month.	Recorded—			Should be—
	Date.	Velocity.	Direction.	
1916.		*Mis./hr.*		
October	14	63	nw	None.
November	11	61	nw	None.
1917.				
January	14	68	se	None.
February	5	66	nw	None.
March	28	69	se	None.
April	4	63	nw	None.
May	26	63	nw	None.
June	17	50	nw	None.

CONDENSED CLIMATOLOGICAL SUMMARY.

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by section, March, 1918.

Section.	Temperature.								Precipitation.					
	Section average.	Departure from the normal.	Monthly extremes.						Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	61.8	+ 6.2	2 stations	89	9†	St. Bernard	26	11	0.81	−4.92	Fort Deposit	2.03	2 stations	0.00
Arizona	53.7	+ 2.0	Yuma Evap. Sta	94	31	Fort Valley	6	9	1.62	+0.46	Spring Valley Range station.	9.24	6 stations	0.00
Arkansas	57.9	+ 5.2	2 stations	96	17	Batesville	16	14	1.31	−3.29	Centerpoint	5.64	Calico Rock	0.24
California	51.5	− 0.3	2 stations	96	30†	Portola	− 5	14	5.75	+1.01	Squirrel Inn	19.87	Calexico	0.72
Colorado	39.2	+ 4.8	2 stations	86	11†	Dillon	−23	16	1.73	+0.34	Palisade Lake	7.05	2 stations	0.00
Florida	69.8	+ 4.2	4 stations	92	1†	2 stations	38	26†	2.53	−0.62	Hypoluxo	6.43	Pensacola	0.32
Georgia	62.0	+ 5.5	Albany	90	1	Ramhurst	24	11	1.42	−3.39	Brunswick	4.47	Montezuma	0.28
Hawaii (February)	68.4	+ 0.4	Mahukona	89	1†	Glenwood	42	13	13.66	+6.48	Honomu	78.86	Waianae	2.11
Idaho	39.0	+ 2.6	Weiser	76	24	New Meadows	−20	6	1.91	+0.95	Oxford R. S.	4.52	Hotsprings	0.14
Illinois	47.4	+ 7.7	White Hall	89	13	Mount Carroll	2	1	0.96	−2.05	Chicago	2.05	Aledo	0.10
Indiana	46.4	+ 6.3	2 stations	83	21†	Howe	12	10	1.88	−1.90	Greencastle	4.26	Elliston	0.37
Iowa	42.9	+ 9.6	Denison	85	19	Sibley	0	10	0.63	−1.14	Dubuque	2.12	3 stations	T.
Kansas	49.8	+ 7.0	3 stations	90	12†	Tribune	1	1	1.74	+0.34	Norwich	5.22	Hanover	0.32
Kentucky	51.6	+ 5.6	2 stations	85	13	Loretto	17	11	1.97	−2.69	Catlettsburg	4.23	Leitchfield	0.23
Louisiana	66.1	+ 4.3	Angola	92	7	Robeline	29	17	2.09	−2.33	Burrwood	5.89	Robeline	0.25
Maryland-Delaware	45.5	+ 3.2	Chewsville, Md	84	19	Deer Park, Md	8	11	3.59	−0.08	Milford, Del	7.06	State Sanatorium	1.57
Michigan	33.7	+ 4.3	Pontiac	78	31	Humboldt	−26	7	1.57	−0.49	Bloomingdale	4.24	Eagle Harbor	0.13
Minnesota	35.6	+10.0	2 stations	77	30	Winton	−24	1	0.84	−0.29	Waseca	5.00	2 stations	0.00
Mississippi	62.8	+ 5.4	Angilla	90	9	2 stations	28	11	0.93	−4.48	Pascagoula	2.46	3 stations	T.
Missouri	50.9	+ 7.8	Amoret (2)	95	13	Bethany (2)	8	1	0.94	−2.05	Hollister	3.80	St. Charles	T.
Montana	37.0	+ 6.8	2 stations	79	25	Bowen	−30	6	0.69	−0.16	Butte	3.15	Foster	T.
Nebraska	44.8	+ 9.4	Kirkwood	89	30	Merriman	− 5	9	0.48	−0.63	Hay Springs	2.00	Stanton	0.00
Nevada	42.1	+ 2.7	Las Vegas	88	31	Marlette Lake	− 5	9	1.29	+0.28	Marlette Lake	7.45	Tecoma	0.00
New England	31.5	+ 1.0	Rutland, Mass	74	21	Pittsburg, N. H	−34	16	2.05	−1.79	Westboro, Mass	3.69	Winslow, Me	0.74
New Jersey	41.8	+ 3.8	Belvidere	82	19	Culvers Lake	0	11	2.06	−1.96	Bridgeton	3.76	Newton	0.99
New Mexico	46.6	+ 2.3	Artesia	90	26	Elizabethtown	−12	1	0.85	+0.07	Bateman's ranch	5.31	7 stations	0.00
New York	34.3	+ 2.1	Port Jervis (4)	77	19†	Raquette Lake	−24	11	2.38	−0.88	Jamestown	6.50	Morrisville	1.05
North Carolina	54.6	+ 4.3	3 stations	88	14	2 stations	16	11	2.25	−2.25	Hot Springs	4.44	Wilmington	0.78
North Dakota	35.0	+12.4	Colgate	82	30	Marmarth	−15	6	0.38	−0.45	Melville	1.20	3 stations	0.00
Ohio	44.0	+ 5.0	6 stations	82	9†	Hillhouse	5	11	2.49	−1.06	Ironton	5.24	Brilliant	0.70
Oklahoma	55.8	+ 3.7	Carnegie	97	12	Goodwell	12	1	2.33	+0.30	Ada	6.69	Waurika	0.51
Oregon	43.9	+ 0.7	Williams	81	30	Crescent	− 5	15	2.53	−1.51	Brookings	10.40	Big Eddy	0.12
Pennsylvania	41.6	+ 3.8	2 stations	82	19†	4 stations	0	11	2.34	−1.35	Bradford	4.98	Saltsburg	0.87
Porto Rico	73.8	0.0	Humacao	96	31	Aibonito	46	25	3.00	−0.53	Inabon Falls	8.00	2 stations	0.10
South Carolina	59.7	+ 4.9	Darlington	89	14	2 stations	29	11	1.83	−2.04	Gaston Shoals	2.99	Effingham	0.69
South Dakota	40.6	+10.0	Wagner	86	25	Ellingson	−14	6	1.10	+0.07	Milbank	2.71	Menno (2)	0.10
Tennesssee	55.8	+ 6.5	3 stations	85	13	Mountain City	16	16	1.82	−3.34	Newport	4.72	Pinewood	T.
Texas	62.8	+ 3.8	2 stations	101	13†	Romero	8	1	1.35	−0.58	Ratcliff	5.16	8 stations	0.00
Utah	41.3	+ 2.8	St. George	81	31	2 stations	−15	1	1.79	+0.18	New Harmony	8.54	2 stations	0.00
Virginia	49.9	+ 4.7	Arcola	88	6	Burkes Garden	13	11	3.57	−0.22	Hot Springs	6.92	Mayhurst	1.70
Washington	42.0	+ 0.3	Mottinger	80	30	Snyders Ranch	− 3	6	3.24	+0.10	Forks	27.27	Sixprong	T.
West Virginia	46.5	+ 4.0	Wheeling	85	20	3 stations	9	11	4.26	+0.12	Holcomb	9.37	2 stations	1.55
Wisconsin	35.3	+ 6.6	Shullsburg	76	18	Winter	−32	10	1.35	−0.27	La Crosse	2.74	Grantsburg	0.27
Wyoming	35.6	+ 6.0	Newcastle	82	26†	Lake Yellowstone	−32	6	1.06	−0.29	Kendall	3.42	Chugwater	T.

† Other dates also.

DESCRIPTION OF TABLES AND CHARTS.

(See MONTHLY WEATHER REVIEW, January, 1918, p. 48.)

TABLE I.—*Climatological data for Weather Bureau Stations, March, 1918.*

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.									Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.				Total.	Departure from normal.	Days with 0.01 inch or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.						
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles.								0-10	In.	In.
New England.							**33.2**	**+0.4**										**72**	**2.13**	**−1.7**										**5.3**		
Eastport	76	67	85	29.79	29.88	−0.05	26.4	−2.5	57	31	34	0	4	19	29	24	20	76	2.17	−2.1	13	8,987	nw.	40	nw.	11	13	6	12	5.6	24.6	0.1
Greenville	1,070	6	...	28.70	29.90	...	23.3	...	56	21	34	−10	8	12	35	...	...	...	2.19	...	9	...		...	...	...	13	8	10	...	22.0	30.0
Portland, Me	103	82	117	29.82	29.95	−.01	31.0	−1.0	67	31	40	6	16	23	30	26	19	63	1.93	−1.8	8	7,890	nw.	56	nw.	3	13	8	10	4.9	12.8	0.0
Concord	288	70	79	29.62	29.95	−.01	31.6	+0.1	65	31	43	2	8	20	38	...	...	...	1.26	−2.1	7	4,992	nw.	37	n.	3	22	3	6	3.3	15.3	0.0
Burlington	404	11	48	29.52	29.98	−.02	27.8	+0.5	60	31	37	−5	11	18	35	...	...	...	1.86	0.0	11	8,744	n.	39	nw.	13	7	10	14	6.0	21.6	0.0
Northfield	876	12	60	29.00	29.98	−.02	27.4	+1.2	60	31	40	−4	11	15	44	23	18	69	1.43	−1.4	9	6,210	n.	34	nw.	3	4	18	9	6.0	15.3	T.
Boston	125	115	188	29.81	29.95	−.02	36.7	+1.7	69	31	46	11	11	28	29	32	26	69	3.19	−0.9	9	8,484	sw.	44	nw.	3	12	10	9	4.7	12.8	0.0
Nantucket	12	14	90	29.93	29.94	−.04	34.2	−2.6	62	21	41	14	11	28	31	32	29	83	2.42	−1.6	8	12,967	sw.	46	sw.	17	10	9	12	6.1	7.5	0.0
Block Island	26	11	46	29.93	29.96	−.02	34.8	−1.1	49	13	40	15	11	29	19	32	30	84	2.54	−1.8	11	14,207	sw.	62	nw.	3	13	6	12	5.5	1.4	0.0
Narragansett Pier	...	9	...	...	...	...	34.6	−0.4	55	13	43	10	8	26	29	...	...	...	2.78	...	9	...	sw.	...	...	...	20	3	8	7.1	0.0	0.0
Providence	160	215	251	29.78	29.96	−.02	36.8	+1.1	68	21	46	9	11	27	35	32	27	74	1.77	−2.8	9	10,687	nw.	65	nw.	3	8	15	8	5.2	5.8	0.0
Hartford	159	122	140	29.80	29.98	−.01	38.4	+3.4	69	31	49	11	11	28	35	32	24	62	2.58	−1.7	8	6,554	nw.	45	nw.	3	14	10	7	4.2	7.0	0.0
New Haven	106	117	155	29.87	29.99	.00	39.2	+3.8	66	21	49	13	11	30	33	33	27	66	2.32	−2.1	9	7,941	nw.	50	nw.	3	14	8	9	4.7	5.8	0.0
Middle Atlantic States.							**44.8**	**+4.8**										**67**	**2.81**	**−0.8**										**4.7**		
Albany	97	102	115	29.88	29.98	−0.03	35.2	+3.1	69	31	46	8	11	24	37	30	25	69	1.89	−0.8	7	5.902	nw.	29	s.	4	19	6	6	3.9	8.4	0.0
Binghampton	871	10	69	29.05	30.00	−.02	37.4	+5.4	75	20	49	9	11	26	42	...	...	...	2.80	+0.2	10	4,888	nw.	32	nw.	10	12	10	9	5.0	4.9	0.0
New York	314	414	454	29.65	30.00	.00	41.2	+3.7	74	19	51	16	11	38	35	35	27	60	1.51	−2.6	11	14,932	nw.	87	nw.	10	9	11	11	5.3	0.6	0.0
Harrisburg	374	94	104	29.63	30.03	.00	44.2	+6.4	76	19	54	18	11	34	33	36	27	57	1.56	−1.6	7	5,589	w.	37	w.	10	15	9	7	4.2	0.1	0.0
Philadelphia	117	123	190	29.88	30.02	.00	44.4	+4.4	78	19	54	18	11	35	38	40	37	78	2.30	−1.2	12	8,127	nw.	47	nw.	10	13	9	9	4.7	T.	0.0
Reading	325	81	98	29.67	30.03	...	43.8	...	78	19	54	17	11	34	35	36	38	59	1.83	−1.7	11	5,948	nw.	38	nw.	10	13	6	12	4.9	T.	0.0
Scranton	805	111	119	29.14	30.02	.00	39.6	+4.7	76	20	51	11	11	29	37	34	30	73	2.23	−0.9	10	5,954	sw.	37	nw.	10	14	8	9	5.3	7.9	0.0
Atlantic City	52	37	48	29.96	30.02	.00	41.2	+2.4	76	19	49	18	11	33	36	37	33	77	2.36	−1.4	13	6,211	sw.	35	nw.	10	12	9	10	4.8	T.	0.0
Cape May	18	13	49	30.03	30.05	+.04	42.8	+2.0	75	19	51	21	11	35	34	...	...	...	3.48	−0.2	12	7,301	n.	42	nw.	10	13	12	6	4.4	T.	0.0
Sandy Hook	22	10	57	29.98	30.00	...	40.2	...	71	19	48	20	11	33	34	35	31	75	1.69	...	13	12,691	nw.	71	nw.	10	15	10	6	4.5	T.	0.0
Trenton	190	159	183	29.79	30.00	...	41.8	...	76	19	53	16	11	31	42	36	31	70	2.02	−2.0	12	9,734	sw.	64	nw.	10	14	9	8	4.9	0.1	0.0
Baltimore	123	100	113	29.90	30.04	+.01	47.2	+5.3	78	19	57	22	11	37	36	40	31	58	4.17	+0.3	12	5,107	sw.	34	sw.	10	13	10	8	4.5	T.	0.0
Washington	112	62	85	29.91	30.03	−.01	48.4	+6.2	79	19	59	23	11	37	37	40	32	61	5.04	+1.2	12	5,549	nw.	46	nw.	10	14	12	5	4.1	0.0	0.0
Lynchburg	681	153	188	29.29	30.04	−.01	52.3	+6.9	80	6	64	26	16	40	39	45	39	66	2.41	−1.4	13	6,218	w.	47	n.	1	14	8	9	4.8	0.0	0.0
Norfolk	91	170	205	29.96	30.06	+.03	52.6	+4.9	81	1	63	23	11	42	39	46	40	69	3.68	−0.6	15	10,805	s.	60	nw.	10	11	15	5	4.6	0.0	0.0
Richmond	144	11	52	29.89	30.04	.00	51.7	+4.8	80	6	64	23	11	40	40	44	37	64	3.98	+0.3	16	7,005	s.	42	nw.	10	10	10	11	5.5	0.0	0.0
Wytheville	2,293	49	55	27.66	30.06	+.01	48.8	+6.5	69	6	59	23	11	38	34	41	36	70	3.75	−0.7	17	5,234	w.	32	w.	10	13	7	11	4.8	0.0	0.0
South Atlantic States.							**59.1**	**+5.2**										**73**	**1.93**	**−2.4**										**5.1**		
Asheville	2,255	70	84	27.71	30.08	+0.02	52.7	+7.8	77	6	64	25	16	42	36	44	38	67	2.25	−2.8	8	7,051	nw.	35	nw.	10	8	13	10	5.4	0.0	0.0
Charlotte	773	153	161	29.22	30.07	+.02	55.8	+5.0	82	1	66	32	11	46	29	48	41	64	2.33	−2.2	10	8,657	ne.	44	sw.	14	10	9	12	5.5	0.0	0.0
Hatteras	11	12	50	30.04	30.05	+.01	53.2	+1.8	70	22	60	33	11	46	26	49	46	82	1.34	−4.1	10	12,165	ne.	48	nw.	10	11	9	11	5.2	0.0	0.0
Manteo	12	4	46	...	...	...	51.9	...	83	1	61	30	12	43	...	...	...	...	1.32	−3.7	4	...	ne.	...	...	...	15	7	9	...	0.0	0.0
Raleigh	376	103	110	29.65	30.06	+.01	55.7	+5.3	84	14	67	30	11	45	33	48	41	65	2.53	−1.7	8	6,929	sw.	34	nw.	26	7	12	12	5.6	0.0	0.0
Wilmington	78	81	91	29.99	30.07	+.02	57.5	+3.8	83	1	68	32	11	48	32	50	46	75	0.78	−2.8	7	6,811	ne.	30	sw.	10	15	9	7	4.3	0.0	0.0
Charleston	48	11	92	30.01	30.06	.00	62.0	+4.8	82	6	70	41	11	54	26	55	52	78	1.65	−2.1	5	8,731	sw.	31	s.	4	14	9	8	4.5	0.0	0.0
Columbia, S. C	351	41	57	29.69	30.07	+.01	60.6	+6.6	85	1	71	35	11	51	31	51	44	63	1.54	−2.2	5	6,125	ne.	34	w.	14	14	10	7	4.6	0.0	0.0
Greenville, S. C	1,039	113	122	28.96	30.06	...	56.6	...	80	1	66	32	11	47	28	49	42	65	2.56	...	8	7,230	ne.	38	w.	14	7	15	9	5.2	0.0	0.0
Augusta	180	62	77	29.86	30.06	.00	62.0	+6.1	85	14	73	38	11	51	35	55	50	73	1.70	−3.2	8	4,655	nw.	25	sw.	14	11	9	11	5.2	0.0	0.0
Savannah	65	150	194	30.00	30.06	.00	63.8	+5.5	87	23	72	43	11	55	28	56	53	79	3.49	−0.2	8	9,409	w.	32	se.	4	8	13	10	5.9	0.0	0.0
Jacksonville	43	200	245	30.01	30.06	.00	67.6	+5.7	83	1	76	54	11	60	25	60	57	80	2.31	−1.2	10	8,967	sw.	37	ne.	16	11	10	10	5.2	0.0	0.0
Florida Peninsula.							**73.2**	**+3.0**										**76**	**1.68**	**−0.6**										**3.3**		
Key West	22	10	64	30.02	30.04	−0.01	75.5	+2.7	84	10	81	65	27	70	15	68	66	75	2.65	+1.2	9	6,461	se.	36	w.	20	25	4	2	2.4	0.0	0.0
Miami	25	71	79	30.03	30.06	...	72.4	+0.4	84	25	79	56	26	66	22	66	63	76	1.48	−1.2	8	6,152	e.	34	ne.	11	15	12	4	3.9	0.0	0.0
Sand Key	23	39	72	30.00	30.03	−.02	75.0	...	82	7	78	66	20	72	11	69	66	75	4.03	...	9	8,588	e.	40	nw.	25	23	5	3	2.5	0.0	0.0
Tampa	35	79	92	30.02	30.06	−.01	71.8	+5.9	87	9	80	56	26	63	26	64	61	77	0.91	−1.9	7	5,084	ne.	28	n.	11	15	9	7	4.5	0.0	0.0
East Gulf States.							**63.7**	**+6.5**										**70**	**0.86**	**−4.9**										**5.1**		
Atlanta	1,174	190	216	28.83	30.07	+0.01	59.2	+6.8	80	14	69	37	11	50	29	50	43	62	0.89	−4.9	8	8,786	w.	42	nw.	15	14	7	10	4.7	0.0	0.0
Macon	370	78	87	29.67	30.07	+.01	62.2	+7.4	85	14	73	42	11	51	34	53	46	64	0.71	−4.8	8	4,808	nw.	23	sw.	14	13	7	11	5.0	0.0	0.0
Thomasville	273	49	58	29.76	30.05	−.01	65.0	+4.8	86	2	75	47	26	55	31	57	52	74	1.41	−3.7	7	4,002	sw.	19	sw.	14	9	11	11	5.7	0.0	0.0
Pensacola	56	149	185	29.99	30.05	−.01	65.0	+3.9	81	7	71	51	16	59	22	60	57	82	0.32	−5.0	3	9,677	sw.	38	se.	11	8	13	10	5.6	0.0	0.0
Anniston	741	9	57	29.29	30.09	+.03	61.0	+8.5	83	9	72	35	18	50	36	...	...	...	0.68	−5.1	7	5,260	se.	30	se.	11	15	10	6	4.4	0.0	0.0
Birmingham	700	11	48	29.32	30.09	+.03	61.8	+6.6	84	9	72	38	11	52	34	52	44	61	0.32	−5.4	4	5,697	s.	25	s.	9	10	12	9	5.1	0.0	0.0
Mobile	57	125	161	29.99	30.05	−.01	65.9	+6.8	82	7	74	48	27	58	27	59	55	76	0.79	−6.4	6	7,543	n.	34	n.	15	7	15	9	5.7	0.0	0.0
Montgomery	223	100	112	29.82	30.07	+.01	64.4	+6.5	85	9	74	44	11	54	31	56	50	67	1.24	−5.1	3	5,386	sw.	24	sw.	9	13	10	8	4.7	0.0	0.0
Corinth	469	6	...	...	...	...	57.4	...	83	22	72	28	11	43	47	...	...	...	0.58	...	5	...	se.	...	...	...	6	24	1	...	0.0	0.0
Jackson	304	5	...	...	...	...	65.2	...	88	9	78	37	26	53	43	...	...	...	1.32	...	2	...	ne.	...	...	...	17	10	4	...	0.0	0.0
Meridian	375	85	93	29.66	30.05	.00	63.4	+7.1	85	9	74	39	26	53	36	55	50	70	0.88	−4.7	4	4,685	sw.	24	sw.	13	15	12	4	4.2	0.0	0.0
Vicksburg	247	65	74	29.79	30.07	+.03	64.0	+5.8	84	9	74	44	17	54	29	55	48	64	0.58	−5.7	4	5,354	e.	24	sw.	9	10	12	9	5.2	0.0	0.0
New Orleans	51	76	84	29.99	30.04	.00	68.9	+6.9	83	14	76	54	17	61	26	62	60	81	1.69	−3.6	9	4,934	sw.	20	sw.	13	9	13	9	5.6	0.0	0.0
West Gulf States.							**62.7**	**+4.8**										**68**	**1.26**	**−1.7**										**5.0**		
Shreveport	249	77	93	29.78	30.05	+0.03	62.5	+4.3	88	13	74	38	17	52	38	54	48	65	1.14	−3.4	6	5,782	s.	25	sw.	9	11	10	10	5.1	0.0	0.0
Bentonville	1,303	11	44	28.64	30.02	+.01	53.7	+6.4	80	22	66	23	10	42	38	...	...	...	3.05	−0.8	7	5,459	s.	27	w.	9	12	10	9	5.0	0.0	0.0
Fort Smith	457	79	94	29.53	30.02	+.01	58.0	+6.7	84	22	70	32	10	46	35	49	42	62	1.69	−1.9	4	6,767	e.	42	w.	9	11	10	10	5.3	0.0	0.0
Little Rock	357	139	147	29.66	30.04	+.01	58.8	+6.1	84	13	69	34	10	49	29	50	43	61	1.49	−3.4	5	7,352	s.	40	sw.	9	6	8	17	6.5	0.0	0.0
Brownsville	57	4	26	...	...	...	71.2	...	90	29	81	42	19	61	42	...	...	...	0.94	...	8	...	s.	...	...	...	...	...	...	...	0.0	0.0
Corpus Christi	20	69	77	30.01	30.03	+.05	67.3	+2.9	82	23	73	45	16	62	26	62	59	82	0.47	−1.4	4	10,109	se.	44	se.	8	6	11	14	6.2	0.0	0.0
Dallas	512	109	117	29.48	30.03	...	61.8	...	89	13	73	36	7	50	37	...	...	...	4.40	...	5	7,301	s.	34	s.	13	10	11	10	5.4	0.0	0.0
Fort Worth	670	106	114	29.28	30.00	+.02	62.2	+5.6	91	12	74	35	17	50	39	52	45	61	0.93	−0.8	5	8,758	s.	36	nw.	14	10	13	8	4.9	0.0	0.0
Galveston	54	106	114	29.99	30.05	+.04	66.6	+4.3	78	14	72	48	16	62	14	61	58	79	1.65	−1.2	5	7,834	s.	35	n.	14	7	10	14	6.4	0.0	0.0
Houston	138	111	121	29.89	30.04	...	67.6	+4.1	86	13	77	44	17	58	30	...	...	...	3.25	...	5	6,108	s.	32	nw.	29	15	12	4	4.0	0.0	0.0
Palestine	510	64	72	29.49	30.03	+.03	63.0	+4.5	88	13	73	36	7	53	33	56	52	74	1.41	−2.1	4	6,438	s.	38	nw.	29	7	11	13	6.0	0.0	0.0
Port Arthur	34	58	66	29.99	30.03	...	66.5	...	84	14	73	44	17	60	23	60	57	79	1.46	...	4	7,048	sw.	28	sw.	13	7	18	6	4.7	0.0	0.0
San Antonio	701	119	132	29.28	30.01	+.03	66.6	+4.5	93	13	78	41	1	56	36	55	46	58	1.45	−0.2	6	6,399	ne.	38	nw.	29	15	12	4	4.2	0.0	0.0
Taylor	582	55	63	29.44	30.05	+.06	63.4	+3.7	91	13	75	38	1	52	36	...	...	...	0.69	−1.9	5	8,215	n.	31	sw.	13	9	11	11	5.8	0.0	0.0

TABLE I.—*Climatological data for Weather Bureau Stations, March, 1918*—Continued.

Districts and stations.	Elevation of instruments: Barometer above sea level.	Elevation: Thermometer above ground.	Elevation: Anemometer above ground.	Pressure: Station, reduced to mean of 24 hours.	Pressure: Sea level, reduced to mean of 24 hours.	Pressure: Departure from normal.	Temperature: Mean max.+mean min.÷2.	Temperature: Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation: Total.	Precipitation: Departure from normal.	Days with 0.01 inch or more.	Wind: Total movement.	Wind: Prevailing direction.	Maximum velocity: Miles per hour.	Maximum velocity: Direction.	Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
Ohio Valley and Tennessee.							**50.2**	**+6.3**										**65**	**1.99**	**−2.2**										**5.0**		
Chattanooga	762	189	213	29.26	30.08	+0.02	57.8	+6.5	81	22	68	33	11	47	32	50	43	64	1.98	−4.2	11	6,757	ne.	46	w.	9	6	15	10	5.7	0.0	0.0
Knoxville	996	102	111	29.00	30.06	.00	55.6	+7.4	77	22	66	30	11	45	34	48	41	66	1.43	−4.2	9	5,361	n.	39	s.	13	6	17	8	5.4	T.	0.0
Memphis	399	76	97	29.66	30.09	+ .05	58.1	+6.0	84	13	68	34	10	48	33	51	45	65	0.70	−5.1	5	7,075	s.	44	w.	23	10	8	13	5.6	0.0	0.0
Nashville	546	168	191	29.48	30.08	+ .03	56.3	+7.1	83	9	68	28	10	44	36	48	40	62	1.86	−3.6	7	7,588	ne.	48	sw.	9	13	8	10	4.7	0.0	0.0
Lexington	989	193	230	29.01	30.09	+ .04	49.2	+5.8	77	9	60	23	10	39	36	....	....	....	1.55	−3.2	9	11,340	sw.	54	w.	9	11	8	12	5.4	0.0	0.0
Louisville	525	219	255	29.49	30.08	+ .03	50.8	+5.5	79	13	62	24	10	39	45	44	37	64	1.22	−3.1	8	9,616	n.	68	sw.	9	13	7	11	5.1	0.0	0.0
Evansville	431	139	175	29.59	30.07	+ .03	52.2	+7.6	78	22	63	24	10	41	42	44	37	62	0.95	−3.6	5	9,509	s.	58	sw.	9	10	12	9	4.7	0.0	0.0
Indianapolis	822	194	230	29.16	30.06	+ .02	47.4	+7.8	78	21	59	20	10	36	47	40	32	61	1.58	−2.4	8	9,677	sw.	66	w.	9	13	8	10	4.5	T.	0.0
Terre Haute	575	96	129	29.42	30.04	....	48.8	....	77	20	61	20	10	37	48	42	36	70	1.64	....	7	8,369	sw.	56	sw.	9	11	11	9	5.0	T.	0.0
Cincinnati	628	11	51	29.38	30.07	+ .02	47.6	+6.8	78	21	60	23	2	35	42	40	33	65	2.28	−1.4	10	6,745	sw.	50	sw.	9	12	9	10	5.1	T.	0.0
Columbus	824	173	222	29.17	30.06	+ .02	45.2	+6.0	76	21	57	19	10	34	37	38	31	64	1.85	−1.4	8	9,169	sw.	70	nw.	10	16	7	8	4.1	0.2	0.0
Dayton	899	181	216	29.06	30.03	....	46.3	+6.0	78	21	58	21	10	35	38	39	32	64	2.17	−1.3	8	8,635	sw.	56	nw.	10	12	11	8	4.4	T.	0.0
Pittsburgh	842	353	410	29.13	30.05	+ .01	44.6	+5.1	75	20	56	17	11	34	41	37	29	61	1.25	−1.8	6	9,148	nw.	59	w.	10	11	6	14	5.4	0.5	0.0
Elkins	1,940	59	67	27.98	30.08	+ .03	44.4	+5.3	75	20	58	14	11	31	46	37	31	70	5.61	+1.5	12	4,662	nw.	54	sw.	10	12	7	12	5.3	T.	0.0
Parkersburg	638	77	84	29.41	30.08	+ .03	47.8	+5.5	77	20	60	21	11	36	37	40	34	69	3.54	−0.3	11	4,647	se.	44	nw.	10	14	6	11	5.0	T.	0.0
Lower Lakes region.							**37.3**	**+4.4**										**70**	**2.33**	**−0.3**										**4.8**		
Buffalo	767	247	280	29.18	30.03	+0.01	34.7	+3.5	68	20	43	8	11	26	29	30	25	73	2.45	−0.2	11	13,253	sw.	60	sw.	12	10	10	11	5.5	10.4	0.0
Canton	448	10	61	29.50	30.00	....	28.4	+0.7	60	31	37	−6	11	20	33	....	....	....	1.37	−1.5	8	10,169	sw.	60	ne.	10	14	11	6	3.9	15.0	T.
Oswego	335	76	91	29.62	30.00	− .01	31.9	+0.5	60	20	40	6	11	24	34	29	25	80	1.53	−1.3	9	7,960	sw.	50	ne.	15	9	7	15	5.8	8.1	0.0
Rochester	523	97	113	29.44	30.03	+ .01	35.6	+4.3	74	20	44	5	11	27	30	30	24	68	2.35	−0.6	11	7,468	sw.	39	w.	2	9	11	11	5.5	10.5	0.0
Syracuse	597	97	113	29.36	30.02	.00	35.4	+4.0	72	21	45	7	11	26	35	....	....	....	1.86	−0.5	13	7,593	nw.	52	nw.	3	8	14	9	6.6	8.3	0.0
Erie	714	130	166	29.25	30.04	+ .02	38.4	+5.3	71	31	47	9	11	30	36	32	26	67	4.03	+1.1	9	10,713	sw.	48	sw.	10	11	13	7	4.9	7.5	0.0
Cleveland	762	190	201	29.22	30.06	+ .03	40.2	+6.0	71	31	49	15	11	31	37	35	30	73	2.38	−0.4	8	10,253	sw.	65	nw.	10	11	10	10	5.2	1.4	0.0
Sandusky	629	62	103	29.35	30.05	+ .03	41.0	+5.8	72	31	50	18	10	32	36	35	29	79	1.92	−0.6	7	10,281	sw.	56	nw.	10	12	11	8	4.8	0.5	0.0
Toledo	628	208	243	29.36	30.06	+ .02	41.7	+6.9	76	21	52	16	10	32	33	35	29	70	2.25	0.0	5	11,278	sw.	52	nw.	10	17	9	5	3.7	1.5	0.0
Fort Wayne	856	113	124	29.12	30.07	....	43.4	+4.5	77	21	55	18	10	32	38	36	30	67	1.62	....	8	7,898	sw.	55	w.	9	17	6	8	3.9	0.4	0.0
Detroit	730	218	245	29.25	30.00	+ .03	39.6	+6.7	73	20	49	15	10	30	30	33	27	69	3.15	+0.8	7	9,874	sw.	42	w.	2	15	10	6	4.0	4.3	0.0
Upper Lakes region.							**33.5**	**+6.2**										**74**	**1.31**	**−0.7**										**4.5**		
Alpena	609	13	92	29.36	30.04	+0.01	30.0	+5.0	70	31	39	0	10	21	35	26	22	73	0.87	−1.2	7	9,020	nw.	44	nw.	2	12	10	9	4.9	10.3	0.0
Escanaba	612	54	60	29.36	30.05	+ .01	29.4	+5.9	64	21	39	−1	7	20	39	26	22	80	0.66	−1.3	4	7,987	s.	43	ne.	9	15	11	5	3.8	7.5	0.0
Grand Haven	632	54	92	29.35	30.05	+ .02	35.2	+4.4	64	20	43	14	10	28	27	31	26	72	1.77	−0.7	6	9,698	s.	39	e.	9	17	8	6	3.6	4.2	0.0
Grand Rapids	707	70	87	29.27	30.06	+ .03	38.4	+5.4	70	31	48	13	10	29	33	33	27	68	2.37	−0.2	5	5,010	nw.	28	e.	9	16	9	6	4.0	5.0	0.0
Houghton	684	62	99	29.28	30.02	− .02	29.8	+6.0	70	19	40	−6	7	20	46	....	....	....	0.23	−1.9	6	8,172	e.	54	w.	2	9	13	9	5.5	1.4	0.0
Lansing	878	11	62	29.08	30.05	....	37.1	....	73	21	48	11	10	26	36	32	27	75	3.58	+1.3	6	5,323	sw.	24	nw.	25	13	10	8	4.7	3.6	0.0
Ludington	637	60	66	29.34	30.05	....	33.2	....	59	20	40	14	7	26	24	30	27	79	2.17	....	6	8,468	s.	43	s.	7	16	7	8	4.0	8.4	0.0
Marquette	734	77	111	29.23	30.05	+ .01	31.7	+8.0	72	19	42	−3	7	22	39	27	22	73	1.13	−1.0	9	9,133	nw.	46	nw.	2	10	8	13	5.5	10.6	T.
Port Huron	638	70	120	29.33	30.04	+ .01	34.8	+5.2	72	19	43	11	11	26	33	30	27	79	1.82	−0.6	6	9,375	sw.	43	n.	10	21	5	5	3.1	5.8	0.0
Saginaw	641	48	82	29.34	30.05	....	35.6	....	71	31	45	12	10	27	30	31	27	74	3.07	+0.4	5	8,114	sw.	40	ne.	9	11	10	10	5.0	8.6	0.0
Sault Sainte Marie	614	11	61	29.33	30.05	+ .02	25.5	+4.2	61	31	35	−12	7	16	41	22	18	78	0.48	−1.4	8	7,693	se.	60	w.	2	10	12	9	5.3	5.0	T.
Chicago	823	140	310	29.16	30.06	+ .03	42.2	+7.8	74	21	50	18	10	34	40	36	30	66	2.05	−0.5	7	9,361	sw.	46	sw.	9	13	11	7	4.6	1.4	0.0
Green Bay	617	109	144	29.36	30.04	.00	34.6	+7.8	65	31	44	6	10	25	31	29	24	70	1.98	−0.4	4	9,709	s.	62	ne.	9	14	10	7	4.8	19.7	0.0
Milwaukee	681	119	133	29.29	30.05	+ .02	38.8	+7.9	71	21	47	11	10	31	33	34	31	77	1.80	−0.9	6	8,862	sw.	46	n.	9	20	3	8	3.8	8.6	0.0
Duluth	1,133	11	47	28.78	30.04	− .02	31.4	+7.3	67	30	41	−1	10	21	38	26	20	68	0.50	−1.0	6	10,666	ne.	46	ne.	9	15	8	8	4.6	6.7	0.0
North Dakota.							**35.6**	**+14.7**										**70**	**0.48**	**−0.5**										**5.0**		
Moorhead	940	8	57	28.99	30.03	−0.05	36.2	+14.8	74	30	48	−6	10	24	37	30	26	75	0.37	−0.8	5	7,468	se.	29	se.	27	20	5	6	3.0	3.6	0.0
Bismarck	1,674	8	57	28.20	30.03	− .03	36.5	+14.4	73	30	48	−8	6	24	39	30	24	68	0.85	−0.2	4	7,959	e.	50	nw.	30	14	4	13	5.3	8.4	0.0
Devils Lake	1,482	11	44	28.37	29.98	− .07	34.2	+15.7	67	30	45	−5	6	23	33	28	23	71	0.22	−0.8	2	9,028	sw.	36	nw.	7	7	10	14	6.2	T.	0.0
Ellendale	1,457	10	56	28.42	30.02	....	34.9	....	75	30	47	−6	6	23	39	29	25	75	0.71	....	4	11,678	nw.	46	n.	9	10	12	9	5.5	7.6	0.0
Grand Forks	835	12	89	....	....	....	35.3	....	79	30	48	−3	6	23	40	31	....	....	0.04	....	3	....	se.	41	se.	30	22	6	3	....	0.0	0.0
Williston	1,872	41	48	27.94	29.96	− .08	35.6	+14.0	74	25	46	−2	6	25	40	30	24	66	0.48	−0.2	5	6,641	w.	36	w.	30	10	14	7	5.6	2.8	0.0
Upper Mississippi Valley.							**44.9**	**+8.9**										**64**	**1.15**	**−1.3**										**4.6**		
Minneapolis	918	10	208	28.99	29.99	....	39.0	....	68	19	48	4	10	30	30	....	....	....	0.93	−0.7	3	9,217	....	42	n.	9	13	7	11	5.0	11.2	0.0
St. Paul	837	201	236	29.11	30.03	−0.02	38.3	+10.1	67	19	48	0	10	29	30	....	....	....	0.88	−0.7	5	9,010	sw.	38	ne.	9	13	9	9	4.8	9.3	0.0
La Crosse	714	11	48	29.26	30.05	+ .01	39.2	+ 8.3	71	20	50	1	10	28	35	....	....	....	2.74	+1.1	6	4,377	se.	22	n.	9	13	5	13	5.0	13.1	0.0
Madison	974	70	78	28.99	30.07	− .03	37.9	+ 7.8	72	20	47	6	10	29	36	32	27	70	2.17	−0.0	7	7,598	sw.	40	n.	9	15	5	11	4.9	10.8	0.0
Wausau	1,247	4	....	28.68	30.04	....	34.2	....	67	19	45	−2	10	23	34	....	....	....	0.78	....	5	....	se.	....	....	....	21	3	7	3.5	8.5	0.0
Charles City	1,015	10	49	28.94	30.04	− .01	39.7	+11.3	75	18	52	3	10	28	39	33	28	72	1.26	−0.7	4	5,754	se.	24	e.	9	15	10	6	4.7	6.5	0.0
Davenport	606	71	79	29.38	30.05	+ .02	44.8	+ 9.4	76	18	56	14	1	34	45	37	30	65	0.66	−1.6	5	6,559	sw.	36	sw.	9	16	7	8	4.3	T.	0.0
Des Moines	861	84	97	29.08	30.01	− .03	45.0	+ 9.3	80	18	57	12	10	33	38	36	27	56	0.29	−1.4	4	6,739	sw.	34	sw.	11	12	9	10	5.2	1.0	0.0
Dubuque	698	81	96	29.30	30.07	+ .03	41.6	+ 8.4	77	18	52	10	1	31	38	35	28	66	2.12	−0.1	4	5,298	s.	35	n.	9	11	11	9	4.6	1.4	0.0
Keokuk	614	64	78	29.36	30.04	+ .01	47.6	+ 9.7	83	13	60	17	10	35	51	39	30	59	0.16	−2.2	5	6,520	sw.	52	w.	9	15	10	6	4.0	T.	0.0
Cairo	356	87	93	29.65	30.04	.00	53.8	+ 6.8	81	22	65	27	10	43	38	46	39	64	1.56	−2.5	5	7,864	sw.	48	sw.	9	7	8	16	6.4	0.0	0.0
Peoria	609	11	45	29.38	30.06	+ .03	45.6	+ 8.6	78	21	59	18	10	32	50	37	32	72	0.91	−2.0	7	6,245	s.	51	sw.	9	19	3	9	3.7	0.2	0.0
Springfield, Ill	644	10	91	29.35	30.04	+ .01	48.9	+ 9.8	83	13	62	21	10	36	52	40	33	63	0.63	−2.4	7	7,241	s.	50	sw.	9	15	7	9	4.4	T.	0.0
Hannibal	534	74	109	29.46	30.04	+ .02	49.1	+ 7.5	89	13	63	18	10	36	52	....	....	....	1.10	−1.7	6	7,926	sw.	58	w.	9	16	10	5	3.5	T.	0.0
St. Louis	567	265	303	29.42	30.03	.00	52.6	+ 9.1	84	13	64	22	10	42	49	43	34	56	0.67	−2.8	4	10,912	sw.	74	sw.	9	15	11	5	4.4	0.0	0.0
Missouri Valley.							**46.9**	**+10.8**										**60**	**0.92**	**−1.0**										**4.3**		
Columbia, Mo	781	11	84	29.18	30.02	−0.01	50.9	+ 9.5	90	13	64	19	10	37	48	....	....	....	0.64	−2.4	3	7,268	s.	52	sw.	9	16	8	7	4.3	0.0	0.0
Kansas City	963	161	181	28.96	30.00	− .02	50.8	+10.0	82	13	62	19	10	39	44	41	30	51	0.48	−2.3	5	9,394	s.	58	w.	9	18	10	3	3.1	T.	0.0
St. Joseph	967	11	49	28.96	30.01	....	49.7	....	84	13	63	17	10	36	43	40	29	54	0.34	....	2	7,331	sw.	56	nw.	9	13	12	6	4.0	0.1	0.0
Springfield, Mo	1,324	98	104	28.61	30.03	+ .01	52.6	+ 9.1	82	13	64	22	10	42	43	44	36	61	1.33	−2.7	9	8,662	s.	56	w.	9	21	6	4	3.2	0.0	0.0
Iola	984	11	50	28.95	30.01	.00	51.0	+ 8.6	85	13	64	20	10	38	44	....	....	....	1.96	−0.4	7	6,054	s.	40	w.	9	15	9	7	4.5	0.0	0.0
Topeka	983	85	101	....	....	....	49.8	+ 8.9	83	26	63	20	10	36	44	....	....	....	0.86	−1.4	4	8,056	s.	58	w.	9	16	10	5	3.7	0.0	0.0
Drexel	1,299	10	54	28.59	30.00	....	45.0	....	80	18	58	14	10	32	41	36	27	60	0.19	....	2	10,267	sw.	44	nw.	9	12	9	10	5.2	1.5	0.0
Lincoln	1,189	11	84	28.71	30.00	− .02	46.8	+10.8	80	18	60	16	10	34	39	38	29	59	0.14	−1.2	5	8,885	s.	58	nw.	9	15	6	10	4.5	0.3	0.0
Omaha	1,105	115	122	28.81	30.01	− .03	47.1	+11.1	80	18	59	15	6	35	35	38	28	55	0.11	−1.3	1	6,761	s.	45	nw.	9	16	9	6	4.0	0.8	0.0
Valentine	2,598	47	54	27.26	30.01	− .02	43.2	+11.3	79	25	58	7	9	29	42	35	28	64	0.93	−0.3	6	7,805	w.	36	n.	31	11	12	8	4.9	4.5	0.0
Sioux City	1,135	94	164	28.78	30.01	− .04	44.0	+11.4	81	18	57	12	6	31	41	37	30	66	0.55	−0.7	4	9,670	s.	48	n.	9	12	12	7	4.5	4.3	0.0
Huron	1,306	59	74	28.60	30.03	− .03	39.6	+12.9	75	30	52	−2	10	27	41	33	27	67	1.11	+0.1	4	8,740	se.	39	ne.	9	12	10	9	4.5	8.2	0.0
Pierre	1,572	70	75	28.31	30.01	− .04	42.7	+13.2	79	30	56	3	6	29	44	35	28	66	1.47	+0.1	6	7,437	nw.	44	n.	31	13	7	11	4.7	17.2	0.0
Yankton	1,233	49	57	28.67	30.01	− .04	43.8	−12.6	80	18	57	10	10	31	40	....	....	....	1.50	+0.4	3	6,458	e.	30	nw.	9	12	10	9	5.1	6.5	0.0

TABLE I.—*Climatological data for Weather Bureau Stations, March, 1918*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.												Precipitation.			Wind.										
	Barometer above sealevel.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sealevel, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Total.	Departure from normal.	Days with 0.01 inch or more.	Total movement.	Prevailing direction.	Maximum velocity: Miles per hour.	Maximum velocity: Direction.	Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Northern Slope.							**39.4**	**+8.6**										**62**	**0.72**	**−0.4**										**5.3**		
Billings	3,140	5	....	....	....	....	41.8	....	76	25	....	1	9	....	44	....	....	....	0.59	....	4	....	sw.	....	....	....	19	5	7	....	1.0	0.0
Havre	2,505	11	44	27.26	29.94	−0.06	35.6	+8.3	69	29	47	−8	5	24	40	31	26	74	0.51	0.0	6	6,723	sw.	36	sw.	30	7	13	11	5.7	3.2	0.0
Helena	4,110	87	112	25.71	29.94	− .07	39.2	+8.2	67	24	50	−1	5	28	34	32	23	56	0.42	−0.3	7	5,822	sw.	38	nw.	30	6	14	11	6.2	3.5	0.0
Kalispell	2,962	11	34	26.85	29.95	− .04	36.1	+3.1	59	30	46	6	6	27	31	32	27	69	0.76	−0.3	11	4,090	nw.	38	sw.	30	2	16	13	6.5	2.1	0.0
Miles City	2,371	48	55	27.42	30.02	.00	41.0	+12.4	75	25	53	−3	6	29	41	34	29	74	0.54	−0.2	6	4,380	se.	36	nw.	30	12	15	4	4.7	2.3	0.0
Rapid City	3,259	50	58	26.56	30.00	− .01	43.4	+11.8	74	30	57	0	6	30	45	35	23	51	0.70	−0.4	6	7,469	w.	46	sw.	11	10	9	12	5.2	5.2	0.0
Cheyenne	6,088	84	101	23.95	29.96	.00	40.8	+7.8	65	18	53	10	6	29	39	32	22	52	0.19	−0.8	4	10,901	w.	72	w.	11	9	13	9	5.1	1.9	0.0
Lander	5,372	60	68	24.59	29.99	.00	41.6	+10.3	67	30	56	4	1	27	43	32	22	52	1.17	−0.4	7	3.974	w.	28	nw.	31	7	15	9	5.1	1.4	0.0
Sheridan	3,790	10	47	26.04	30.00	....	37.4	....	72	30	51	−9	6	24	44	31	26	69	3.32	....	7	3,836	nw.	28	w.	11	10	9	12	5.4	11.8	0.0
Yellowstone Park	6,200	11	48	23.82	30.04	+ .02	31.8	+5.3	59	29	42	−9	6	21	37	27	22	67	1.89	−0.3	14	7,109	s.	35	sw.	9	12	9	10	5.0	18.1	0.0
North Platte	2,821	11	51	27.06	30.02	+ .02	45.4	+10.1	80	18	62	15	6	29	54	35	25	58	0.32	−0.6	4	6,136	n.	39	nw.	9	16	6	9	3.8	0.6	0.0
Middle Slope.							**49.7**	**+7.2**										**54**	**1.46**	**0.0**										**4.4**		
Denver	5,292	106	113	24.69	29.96	+0.01	47.0	+8.3	72	18	60	14	1	34	40	37	25	49	1.04	0.0	6	6,150	se.	44	nw.	9	16	9	6	4.2	2.5	0.0
Pueblo	4,685	80	86	25.26	29.97	+ .05	46.8	+6.2	74	18	62	6	1	32	45	36	23	46	0.35	−0.5	5	5,656	nw.	49	w.	13	12	7	12	5.5	0.6	0.0
Concordia	1,392	50	58	28.52	30.01	.00	48.4	+7.7	80	26	61	18	10	35	43	39	28	56	0.77	−0.7	4	7,460	s.	52	nw.	9	11	15	5	4.7	T.	0.0
Dodge City	2,509	11	51	27.37	29.99	+ .02	49.4	+7.7	83	11	63	20	1	35	46	39	31	58	2.59	+1.7	6	8,447	s.	51	nw.	9	16	10	5	3.7	T.	0.0
Wichita	1,358	139	158	28.54	29.98	− .01	50.9	+6.8	83	26	63	21	6	39	40	43	35	63	2.44	+0.2	6	10,589	s.	65	nw.	9	14	11	6	4.1	0.0	0.0
Altus	1,410	5	....	....	....	....	57.6	....	90	12	72	29	1	43	46	....	....	....	2.35	....	4	....	se.	....	....	....	20	5	6	....	0.0	0.0
Muskogee	652	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Oklahoma City	1,214	10	47	28.72	30.00	+ .02	55.8	+6.6	90	13	69	25	10	42	38	44	34	55	1.55	−0.8	4	11,302	s.	48	nw.	9	11	14	6	4.6	0.0	0.0
Southern Slope.							**59.0**	**+5.8**										**41**	**0.52**	**−0.4**										**3.8**		
Abilene	1,738	10	52	28.19	30.00	+0.04	61.4	+6.5	93	12	75	32	17	48	49	46	31	41	0.98	−0.4	3	8,253	sw.	35	nw.	29	12	4	15	5.4	0.0	0.0
Amarillo	3,676	10	49	26.26	29.99	+ .04	52.6	+7.6	83	8	67	23	1	38	43	40	27	46	1.06	+0.4	5	8,087	sw.	39	sw.	13	20	9	2	3.2	0.0	0.0
Del Rio	944	64	71	29.04	30.02	+ .07	67.4	+5.7	94	8	80	40	17	55	39	....	....	....	0.06	−1.1	2	7,450	se.	34	n.	15	21	8	2	3.0	0.0	0.0
Roswell	3,566	75	85	26.37	29.98	+ .08	54.6	+3.3	83	12	70	24	18	39	50	41	24	36	T.	−0.5	0	7,021	w.	42	w.	13	15	13	3	3.8	T.	0.0
Southern Plateau.							**52.5**	**+1.6**										**47**	**0.84**	**+0.3**										**3.8**		
El Paso	3,762	110	133	26.22	29.98	+0.10	56.2	+0.3	80	12	69	29	17	44	38	43	27	38	0.08	−0.3	3	9,629	w.	48	ne.	14	12	15	4	3.9	T.	0.0
Santa Fe	7,013	57	66	23.23	29.97	+ .08	42.8	+3.4	63	31	53	21	1	33	33	35	26	59	1.46	+0.7	11	5,894	sw.	42	sw.	8	8	16	7	5.2	7.3	0.0
Flagstaff	6,908	8	57	23.34	29.97	+ .06	38.2	+2.3	62	31	49	11	9	27	37			....	4.50	....	8	....	w.	48	w.	8	17	8	6	....	5.0	0.0
Phoenix	1,108	76	81	28.82	29.98	+ .07	62.4	+1.9	87	31	76	37	9	49	37	50	38	49	0.93	+0.4	4	4,112	e.	28	e.	16	18	7	6	3.6	0.0	0.0
Yuma	141	9	54	29.83	29.98	+ .04	66.0	+1.5	93	31	80	43	20	52	38	52	38	42	0.72	+0.4	3	4,624	n.	34	e.	19	22	5	4	2.4	0.0	0.0
Independence	3,910	11	42	25.98	29.97	+ .03	49.6	0.0	77	31	62	27	9	38	36	40	28	48	1.02	+0.5	6	....	s.	....	....	....	17	5	9	3.8	0.2	0.0
Needles	488	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Middle Plateau.							**43.2**	**+2.3**										**56**	**1.60**	**+0.4**										**4.9**		
Reno	4,532	74	81	25.45	30.04	+0.06	40.4	−0.6	73	30	52	14	9	29	41	34	26	62	2.51	+1.3	9	4,767	w.	42	sw.	4	12	6	13	5.0	20.1	0.0
Tonopah	6,090	12	20	24.02	29.97	....	41.6	....	65	30	51	19	13	32	27	34	25	55	0.57	−0.8	8	8,581	se.	45	se.	10	16	8	7	3.6	1.4	0.0
Winnemucca	4,344	18	56	25.60	30.02	+ .01	42.2	+2.6	73	30	55	22	5	29	46	35	26	59	1.95	+1.0	11	5,715	sw.	42	sw.	11	12	5	14	5.7	3.7	0.0
Modena	5,479	10	43	24.61	30.00	+ .04	40.5	+1.3	68	31	54	14	1	28	41	33	24	59	1.60	+0.3	9	8,665	sw.	52	w.	8	14	5	12	5.0	0.3	0.0
Salt Lake City	4,360	163	203	25.62	30.01	+ .03	45.4	+4.0	70	24	54	23	1	36	29	37	28	54	1.81	−0.2	6	6,522	nw.	38	sw.	11	12	7	12	5.5	7.8	0.0
Grand Junction	4,602	*82	**96	25.38	29.98	+ .04	47.7	+4.2	70	26	60	25	16	36	32	38	27	50	1.18	+0.5	7	5,548	se.	48	w.	8	14	8	9	4.7	T.	0.0
Northern Plateau.							**44.3**	**+4.1**										**60**	**1.20**	**−0.4**										**6.5**		
Baker	3,471	48	53	26.40	30.02	−0.01	39.9	+4.4	66	30	50	10	5	30	32	35	28	64	0.62	−0.8	9	5,579	se.	30	s.	17	8	10	13	5.9	2.6	0.0
Boise	2,739	78	86	27.16	30.04	+ .01	45.5	+3.3	70	24	55	19	6	36	30	38	29	56	1.78	+0.3	9	4,261	se.	26	w.	11	5	9	17	7.0	4.6	0.0
Lewiston	757	40	48	29.20	30.02	− .01	47.2	+3.2	73	24	57	25	6	37	33	....	....	....	1.42	+0.1	12	3,231	e.	27	nw.	3	3	9	19	7.2	0.8	0.0
Pocatello	4,477	60	68	25.45	30.02	+ .01	41.3	+4.4	66	24	51	15	6	32	30	34	26	58	1.39	−0.4	10	8,408	se.	46	sw.	8	10	11	10	5.5	1.1	0.0
Spokane	1,929	101	110	27.91	29.98	− .03	43.0	+4.1	68	24	51	24	6	35	31	37	30	64	0.75	−0.8	8	5,792	sw.	36	sw.	22	3	9	19	7.5	3.2	0.0
Walla Walla	991	57	65	28.92	30.00	− .02	49.0	+5.0	73	29	58	27	6	40	32	41	33	56	1.26	−0.6	11	4,562	s.	32	s.	17	6	14	11	6.1	3.2	0.0
North Pacific Coast Region.							**44.8**	**+0.1**										**78**	**4.93**	**+0.3**										**7.0**		
North Head	211	11	56	29.76	29.99	−0.02	43.6	−0.7	55	28	47	32	2	40	13	43	41	90	5.62	+0.4	23	15,057	se.	72	se.	17	5	6	20	7.3	3.0	0.0
North Yakima	1,071	4	....	....	....	....	43.7	....	76	29	57	19	6	30	42	....	....	....	0.24	....	3	....	nw.	....	....	....	16	6	9	....	T.	0.0
Port Angeles	29	8	53	29.95	29.98	....	41.1	....	61	28	49	25	6	34	25	....	....	....	2.73	+0.6	17	4,544	s.	36	nw.	31	8	6	17	6.3	4.2	0.0
Seattle	125	215	250	29.88	30.01	+ .02	44.0	−0.2	65	29	50	29	6	38	22	40	36	74	3.92	+0.3	19	8,560	se.	44	sw.	8	2	12	17	7.7	T.	0.0
Tacoma	213	113	120	29.78	30.01	+ .01	44.3	+0.1	72	29	51	26	6	38	32	41	36	74	3.82	−0.2	18	5,324	sw.	26	sw.	19	2	10	19	7.7	1.5	0.0
Tatoosh Island	86	7	57	29.84	29.94	− .02	42.4	−0.5	53	15	46	33	9	38	11	41	38	85	12.35	+3.8	26	13,879	s.	56	s.	21	5	6	20	7.2	2.2	0.0
Medford	1,425	4	....	....	....	....	46.8	....	78	29	58	19	6	35	41	....	....	....	1.69	....	12	....	nw.	....	....	....	8	5	18	....	0.6	0.0
Portland, Oreg.	153	68	106	29.86	30.02	.00	46.7	+0.4	76	29	54	31	6	40	28	43	38	74	3.47	−1.7	17	4,557	nw.	26	sw.	11	6	7	18	6.8	T.	0.0
Roseburg	510	9	57	29.47	30.03	− .01	48.0	+1.4	79	29	58	26	6	38	38	43	37	72	2.57	−1.4	12	2,220	s.	24	s.	17	9	9	13	5.7	T.	0.0
Middle Pacific Coast Region.							**51.8**	**+0.5**										**73**	**4.02**	**−0.2**										**5.4**		
Eureka	62	73	89	29.99	30.06	0.00	48.5	+0.5	65	16	55	32	6	42	23	45	42	80	5.84	−1.1	18	5,426	se.	48	se.	17	7	6	18	6.9	T.	0.0
Mount Tamalpais	2,375	11	18	27.54	30.03	− .03	46.8	−0.3	70	30	52	30	5	42	17	42	38	74	2.78	−2.4	14	9,525	sw.	58	sw.	11	9	7	15	5.8	T.	0.0
Point Reyes Light	490	7	18	29.48	30.00	....	51.0	+1.4	66	29	56	38	6	46	19	....	....	....	2.27	....	14	11,333	nw.	73	se.	11	10	9	12	5.7	0.0	0.0
Red Bluff	332	50	56	29.67	30.03	− .01	53.5	−0.3	84	29	63	28	5	44	33	47	40	67	4.28	+0.5	12	4,087	se.	30	se.	17	14	3	14	5.1	0.0	0.0
Sacramento	69	106	117	29.98	30.05	+ .02	53.6	−0.6	80	30	63	32	6	44	30	49	44	73	4.00	+1.0	13	5,485	s.	32	se.	18	15	8	8	4.1	0.0	0.0
San Francisco	155	209	213	29.88	30.05	− .01	54.9	+2.2	78	30	62	40	5	48	28	49	45	72	2.73	−0.4	10	5,145	sw.	30	sw.	18	13	6	12	4.8	0.0	0.0
San Jose	141	12	110	29.89	30.04	....	54.5	+0.8	81	30	65	35	14	44	37	....	....	....	4.48	+1.5	10	4,557	nw.	36	s.	17	12	6	13	5.2	0.0	0.0
South Pacific Coast Region.							**57.7**	**+2.6**										**71**	**5.52**											**2.9**		
Fresno	327	89	98	29.69	30.05	+0.04	56.4	+1.5	80	31	66	38	14	47	27	50	44	69	4.19	+2.4	10	4,581	nw.	29	se.	17	16	3	12	4.6	0.0	0.0
Los Angeles	338	159	191	29.68	30.04	+ .02	59.1	+3.5	88	30	67	43	8	51	30	52	46	70	6.21	+3.2	8	4,597	ne.	24	sw.	12	11	9	11	5.3	0.0	0.0
San Diego	87	62	70	29.94	30.03	+ .01	58.5	+2.3	80	17	65	44	9	52	25	52	48	74	4.57	+2.9	7	4,464	nw.	38	s.	12	11	7	13	5.2	0.0	0.0
San Luis Obispo	201	32	40	29.84	30.06	.00	56.8	+3.0	86	30	67	36	9	46	40	49	44	71	7.12	+3.1	11	3,582	nw.	24	se.	10	15	4	12	5.0	0.0	0.0
West Indies.																																
San Juan, P. R.	82	8	54	29.95	30.04	+0.02	74.2	....	87	26	80	66	25	68	18	....	....	....	2.89	−0.3	19	9,737	e.	34	ne.	1	20	10	1	3.2	0.0	0.0
Panama Canal.																																
Balboa Heights	118	7	97	29.78	29.90	....	79.4	....	90	16	88	67	26	70	22	71	69	79	1.25	+0.6	2	7,888	n.	35	n.	11	17	14	0	3.5	0.0	0.0
Colon	36	30	97	29.87	29.91	....	78.7	....	84	28	82	72	13	76	11	73	71	77	0.41	−1.2	6	11,141	n.	30	ne.	12	7	23	1	4.6	0.0	0.0
Alaska.																																
Juneau	80	11	49	....	....	....	27.6	....	41	31	32	9	10	23	20	25	20	74	4.34	....	18	4,565	ne.	26	ne.	8	5	5	21	7.6	37.8	25.2

* Elevation changed to 60 feet on Mar. 15, 1918.

** Elevation changed to 68 feet on Mar. 15, 1918.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during March, 1918, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Abilene, Tex	1-2			0.89														0.27			
Albany, N. Y	9-10			0.77														*			
Alpena, Mich	9-10			0.52														*			
Amarillo, Tex	28			0.44														0.28			
Anniston, Ala	19			0.37														0.24			
Asheville, N. C	23			0.86														0.50			
Atlanta, Ga	4			0.27														0.27			
Atlantic City, N. J	4			0.48														0.25			
Augusta, Ga	17			1.19														0.21			
Baker, Oreg	26			0.21														*			
Baltimore, Md	21			1.71														0.60			
Bentonville, Ark	3			0.88														0.50			
Binghamton, N. Y	14			1.00														0.41			
Birmingham, Ala	19			0.28														0.08			
Bismarck, N. Dak	8-9			0.42														*			
Block Island, R. I	10			1.32														0.35			
Boise, Idaho	26			0.69														0.13			
Boston, Mass	1			1.15														0.22			
Buffalo, N. Y	9-10			0.70														*			
Burlington, Vt	9-10			0.82														*			
Cairo, Ill	23-24	7:15 p.m.	6:10 a.m.	1.30	7:59 p.m.	8:28 p.m.	0.06	0.16	0.28	0.41	0.51	0.56	0.62								
Canton, N. Y	14-15			0.46														*			
Charles City, Iowa	13-14			0.64														*			
Charleston, S.C	17	8:05 a.m.	12:20 p.m.	0.93	10:56 a.m.	11:15 a.m.	0.34	0.09	0.15	0.33	0.51										
Charlotte, N. C	4			0.80														0.38			
Chattanooga, Tenn	9			0.41														0.40			
Cheyenne, Wyo	5-6			0.16														*			
Chicago, Ill	13-14			1.31														*			
Cincinnati, Ohio	9			0.24														0.21			
Cleveland, Ohio	9			1.08														0.46			
Columbia, Mo	23			0.31														0.15			
Columbia, S. C	20			0.30														0.27			
Columbus, Ohio	13			0.85														0.23			
Concord, N. H	9-10			0.67														*			
Concordia, Kans	3			0.60														0.16			
Corpus Christi, Tex	15			0.24														0.18			
Dallas, Tex	29			0.38														0.36			
Davenport, Iowa	9			0.45														*			
Dayton, Ohio	13			1.24														0.26			
Del Rio, Tex	15			0.03														0.03			
Denver, Colo	27-28			0.74														*			
Des Moines, Iowa	9			0.14														*			
Detroit, Mich	13-14	3:45 p.m.	8:05 a.m.	2.00	10:38 p.m.	11:02 p.m.	0.81	0.13	0.28	0.37	0.48	0.54									
Devils Lake, N. Dak	28			0.21														0.08			
Dodge City, Kans	28-29			1.59														*			
Drexel, Nebr	14			0.15														*			
Dubuque, Iowa	13	7:15 a.m.	4:25 p.m.	1.55	9:26 a.m.	10:26 a.m.	0.38	0.19	0.27	0.28	0.29	0.29	0.31	0.45	0.54	0.59	0.67	0.84			
Duluth, Minn	9			0.25														*			
Eastport, Me	10			0.73														*			
Elkins, W. Va	13			2.31														0.43			
Ellendale, N. Dak	8-9			0.54														*			
El Paso, Tex	20			0.06														0.03			
Erie, Pa	9			1.24														0.57			
Escanaba, Mich	9			0.50														*			
Eureka, Cal	12			0.96														0.25			
Evansville, Ind	4			0.60														0.20			
Flagstaff, Ariz	7-8			1.64														*			
Fort Smith, Ark	28			0.82														0.39			
Fort Wayne, Ind	13-14			0.97														*			
Fort Worth, Tex	30			0.26														0.22			
Fresno, Cal	19			1.13														0.18			
Galveston, Tex	22	4:45 p.m.	7:10 p.m.	1.08	4:53 p.m.	5:06 p.m.	0.01	0.28	0.47	0.52											
Grand Haven, Mich	14			0.62														0.16			
Grand Junction, Colo	6			1.02														0.16			
Grand Rapids, Mich	14			0.76														0.18			
Green Bay, Wis	9			1.27														*			
Greenville, S. C	4			0.79														0.47			
Hannibal, Mo	23			0.50														0.17			
Harrisburg, Pa	13			0.65														0.20			
Hartford, Conn	10			1.00														0.33			
Hatteras, N. C	21			0.43														0.15			
Havre, Mont	4			0.28														*			
Helena, Mont	4-5			†0.13														*			
Houghton, Mich	4-5			0.09														*			
Houston, Tex	22	9:40 a.m.	4:05 p.m.	2.01	1:13 p.m.	1:52 p.m.	0.01	0.19	0.52	0.66	0.71	0.79	1.17	1.50	1.58						
Houston, Tex	29	5:45 a.m.	8:35 a.m.	1.04	6:40 a.m.	7:09 a.m.	0.11	0.18	0.23	0.26	0.49	0.66	0.75								
Huron, S. Dak	8-9			0.58														0.0			
Independence, Cal	6-7			0.40														*			
Indianapolis, Ind	13			0.63														0.32			
Iola, Kans	23			0.71														0.34			
Jacksonville, Fla	4	4:58 p.m.	5:30 p.m.	0.51	5:03 p.m.	5:17 p.m.	0.01	0.28	0.44	0.50											
Kalispell, Mont	11			0.17														*			
Kansas City, Mo	3			0.43														0.16			
Keokuk, Iowa	13			0.07														*			
Key West, Fla	19-20	9:25 p.m.	D. N. a.m.	1.67	9:59 p.m.	10:28 p.m.	0.08	0.15	0.43	0.62	0.76	0.90	0.97								
Knoxville, Tenn	9			0.30														0.30			
La Crosse, Wis	13-14			2.04														*			
Lander, Wyo	27			0.66														0.28			
Lansing, Mich	31			0.67														0.28			
Lewiston, Idaho	25			0.31														0.20			
Lexington, Ky	4			0.43																	
Lincoln, Nebr	28-29			0.06														*			
Little Rock, Ark	22			0.28														0.24			
Los Angeles, Cal	19			0.88														0.43			
Louisville, Ky	24			0.36														0.17			
Ludington, Mich	9-10			1.12														*			
Lynchburg, Va	4			0.30														0.30			
Macon, Ga	7			0.22														0.16			
Madison, Wis	13-14			1.19														*			
Marquette, Mich	5-6			0.52														*			

* Self register not in use. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during March, 1918, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive rate began.	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Memphis, Tenn	3-4			0.52														*			
Meridian, Miss.	19			0.36														0.17			
Miami, Fla	19			0.65														0.31			
Milwaukee, Wis	14			0.79														*			
Minneapolis, Minn	9			0.84														*			
Mobile, Ala	10			0.34														0.34			
Modena, Utah	11-12			0.46														*			
Montgomery, Ala	31			0.81														0.49			
Moorhead, Minn	8-9			0.28														*			
Mount Tamalpais, Cal	11			0.30														0.16			
Nantucket, Mass	10			0.67														0.26			
Nashville, Tenn	23			0.90														0.75			
New Haven, Conn	10			0.78														0.22			
New Orleans, La	22			0.40														0.39			
New York, N. Y	14			0.56														0.16			
Norfolk, Va	20			0.65														0.34			
Northfield, Vt	9-10			0.80														*			
North Head, Wash	23			1.26														0.25			
North Platte, Nebr	28			0.22														0.08			
Oklahoma, Okla	29			0.65														0.25			
Omaha, Nebr	14			0.11														*			
Oswego, N. Y	9-10			0.71														*			
Palestine, Tex	29			0.76														0.65			
Parkersburg, W. Va	13			2.20														0.31			
Pensacola, Fla	30			0.19														0.12			
Peoria, Ill	22			0.62														0.38			
Philadelphia, Pa	13-14			0.82														0.32			
Phoenix, Ariz	19			0.54														0.29			
Pierrre, S. Dak	12-13			0.87														*			
Pittsburgh, Pa.	13			0.30														0.13			
Pocatello, Idaho	12			0.37														0.19			
Point Reyes Light, Cal	17			0.90														0.15			
Port Angeles, Wash	22			0.50														0.19			
Port Huron, Mich	13-14			0.79														*			
Portland, Me	9-10			1.12														*			
Portland, Oreg	22			0.58														0.14			
Providence, R. I	9-10			0.96														*			
Pueblo, Colo	21			0.13														*			
Raleigh, N. C	20			0.86														0.65			
Rapid City, S. Dak	13			0.24														*			
Reading, Pa.	13			0.56														0.29			
Red Bluff, Cal	24			0.44														0.25			
Reno, Nev	6-7			0.74														*			
Richmond, Va	6	6:48 p. m.	8:00 p. m.	0.63	6:53 p. m.	7:22 p. m.	0.01	0.16	0.19	0.20	0.21	0.34	0.57								
Rochester, N. Y	9-10			0.93														*			
Roseburg, Oreg	24			0.24														0.13			
Roswell, N. Mex	1			T.														T.			
Sacramento, Cal	10			1.44														0.30			
Saginaw, Mich	13-14			1.45														*			
St. Joseph, Mo	3			0.33														*			
St. Louis, Mo	23			0.24														0.17			
St. Paul, Minn	8-9			0.67														*			
Salt Lake City, Utah	12-13			0.93														*			
San Antonio, Tex	29			0.58														0.48			
San Diego, Cal	11			1.77														0.38			
Sand Key, Fla	18	10:40 p. m.	11:45 p. m.	1.10	11:06 p. m.	11:40 p. m.	0.06	0.16	0.50	0.74	0.75	0.83	0.92	1.03							
	19	9:40 p. m.	10:40 p. m.	0.69	9:54 p. m.	10:14 p. m.	0.03	0.33	0.48	0.54	0.61										
	20	1:10 p. m.	2:30 a. m.	0.85	1:21 a. m.	1:41 a. m.	0.04	0.21	0.45	0.57	0.65										
	20	3:42 p. m.	5:30 p. m.	0.88	4:07 p. m.	4:45 p. m.	0.16	0.05	0.10	0.17	0.30	0.45	0.52	0.64	0.70						
Sandusky, Ohio	13-14			0.91														*			
Sandy Hook, N. J	14			0.52														0.17			
San Francisco, Cal	10			0.75														*			
San Jose, Cal	10			1.32														0.50			
San Luis Obispo, Cal	7																	0.26			
Santa Fe, N. Mex	20-21			1.07														*			
Sault Ste. Marie, Mich	9			0.19														*			
Savannah, Ga	4	3:37 p. m.	7:20 p. m.	1.73	5:20 p. m.	6:18 p. m.	0.55	0.10	0.14	0.17	0.22	0.26	0.30	0.42	0.47	0.55	0.75	0.87			
Scranton, Pa	13-14			0.73														*			
Seattle, Wash	22			0.45														0.21			
Sheridan, Wyo	13			1.74														*			
Shreveport, La	30			0.65														0.56			
Sioux City, Iowa	13-14			0.35														*			
Spokane, Wash	13			0.32														*			
Springfield, Ill	9			0.20														*			
Springfield, Mo	22			0.48														0.21			
Syracuse, N. Y	13-14			0.59														*			
Tacoma, Wash	23			0.99														0.19			
Tampa, Fla	18	3:39 p. m.	4:20 p. m.	0.55	3:44 p. m.	4:09 p. m.	0.01	0.07	0.16	0.16	0.33	0.53									
Tatoosh Island, Wash	21			1.20														0.27			
Taylor, Tex	29			0.35														0.35			
Terre Haute, Ind	23			0.70														0.31			
Thomasville, Ga	18			0.72														0.29			
Toledo, Ohio	13			1.30														0.51			
Tonopah, Nev	18-19			0.18														*			
Topeka, Kans	28			0.41														0.15			
Trenton, N. J	22			0.36														0.21			
Valentine, Nebr	8-9			0.48														*			
Vicksburg, Miss	19			0.44														0.12			
Walla Walla, Wash	9			0.42														*			
Washington, D. C	21-22			2.16														*			
Wausau, Wis	9			0.40														*			
Wichita, Kans	28-29			1.15														*			
Williston, N. Dak	8-9			0.25														*			
Wilmington, N. C	24			0.27														0.25			
Winnemucca, Nev	7			0.41														0.24			
Wytheville, Va	20			0.91														0.40			
Yankton, S. Dak	13			1.00														0.18			
Yellowstone Park, Wyo	8			0.58														*			

* Self-register not in use. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE III.—*Data furnished by the Canadian Meteorological Service, March, 1918.*

Stations.	Altitude above M. S. L.* Jan. 1, 1916.	Pressure.			Temperature.						Precipitation.		
		Station, reduced to mean of 24 hours.	Sea-level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Mean maximum.	Mean minimum.	Highest.	Lowest.	Total.	Departure from normal.	Total snowfall.
	Feet.	*Inches.*	*Inches.*	*Inches.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*Inches.*	*Inches.*	*Inches.*
St. Johns, N. F.	125	29.43	29.57	−0.31	21.3	−6.4	28.4	14.3	40	−2	6.14	+1.38	52.0
Sydney, C. B. I.	48	29.75	29.79	− .09	21.2	−5.0	31.2	11.2	48	−6	3.44	−1.49	31.0
Halifax, N. S.	88	29.72	29.83	− .11	25.7	−3.3	35.0	16.4	53	−6	3.38	−2.08	30.2
Yarmouth, N. S.	65	29.78	29.85	− .10	29.1	−1.7	35.8	22.5	48	0	2.53	−2.32	23.7
Charlottetown, P. E. I.	38	29.77	29.81	− .09	19.9	−5.5	28.1	11.8	42	−16	3.68	+0.47	30.0
Chatham, N. B.	28	29.84	29.87	−0.03	19.9	−3.1	31.9	7.9	50	−21	2.01	−1.46	30.1
Father Point, Que.	20	29.89	29.92	+ .02	16.6	−3.7	25.4	7.9	43	−14	0.23	−2.50	2.3
Quebec, Que.	296	29.60	29.94	− .02	21.0	−0.2	29.7	12.4	46	−8	1.44	−1.82	14.3
Montreal, Que.	187	29.75	29.97	− .03	25.7	+1.9	33.2	18.2	53	0	2.66	−1.13	26.1
Stonecliffe, Ont.	489	29.36	29.99	− .02	24.1	+5.1	36.6	11.6	58	−14	0.80	−1.26	8.0
Ottawa, Ont.	236	29.73	30.01	0.00	26.5	+5.0	36.6	16.5	55	−6	1.98	−0.74	19.8
Kingston, Ont.	285	29.68	30.00	− .01	29.4	+3.8	37.6	21.1	54	−4	1.03	−1.61	3.7
Toronto, Ont.	379	29.61	30.04	+ .02	33.5	+6.2	42.4	24.7	67	6	2.08	−0.56	10.9
White River, Ont.	1,244	28.62	29.98	− .05	18.5	+6.3	34.4	2.6	55	−34	1.31	−0.07	12.1
Port Stanley, Ont.	592	29.40	30.06	+ .03	32.7	+5.5	41.1	24.2	56	5	2.90	+0.02	6.4
Southampton, Ont.	656	29.28	....	....	28.9	+4.2	37.2	20.6	60	5	1.65	−1.00	14.2
Parry Sound, Ont.	688	29.29	30.00	−0.02	27.0	+5.9	37.0	17.0	59	−4	0.18	−2.05	1.8
Port Arthur, Ont.	644	29.27	30.00	− .05	26.5	+9.7	38.0	15.0	60	−9	0.33	−0.64	3.3
Winnipeg, Man.	760	29.13	29.99	− .10	29.2	+16.9	40.7	17.7	64	−13	0.91	−0.12	5.5
Minnedosa, Man.	1,690	28.10	29.97	− .09	26.8	+14.3	37.9	15.8	62	−24	0.67	+0.02	5.3
Qu'Appelle, Sask.	2,115	27.61	29.90	−0.14	29.5	+14.6	40.1	18.9	64	−16	1.36	+0.59	12.3
Medicine Hat, Alberta.	2,144	27.53	29.84	− .16	34.5	+7.0	45.7	23.2	68	−9	0.36	−0.40	3.5
Swift Current, Sask.	2,392	27.25	29.87	− .15	30.5	+8.5	42.2	18.9	69	−14	0.96	+0.15	8.9
Calgary, Alberta.	3,428	26.25	29.88	− .07	26.8	+0.6	42.9	10.7	66	−20	0.44	−0.28	4.4
Banff, Alberta.	4,521	25.19	29.88	− .06	26.0	+5.8	36.1	15.9	51	−31	1.47	+0.06	14.2
Edmonton, Alberta.	2,150	27.49	29.82	−0.14	25.2	+1.0	36.9	13.5	62	−28	0.92	+0.20	9.2
Prince Albert, Sask.	1,450	28.30	29.90	− .18	23.2	+11.2	35.3	11.2	61	−20	0.85	+0.08	8.0
Battleford, Sask.	1,592	28.10	29.89	− .17	23.8	+10.7	36.4	11.2	62	−23	1.44	+0.98	14.4
Kamloops, B. C.	1,262	28.65	29.97	+ .05	38.3	+2.2	47.2	29.5	70	8	0.23	−0.34	T.
Victoria, B. C.	230	29.70	29.96	− .01	42.9	+1.0	48.4	37.4	60	28	2.79	−0.33	0.2
Barkerville, B. C.	4,180	25.46	29.81	−0.07	27.8	+1.7	35.5	20.0	47	−5	3.29	+1.40	32.2
Hamilton, Bermuda.	151	29.95	30.12	+ .04	63.5	+1.3	69.2	57.8	73	51	2.72	−2.41	0.0

* See description of Table III given on p. 48 of the REVIEW for January, 1918.

Chart I. Hydrographs of Several Principal Rivers, March, 1918.

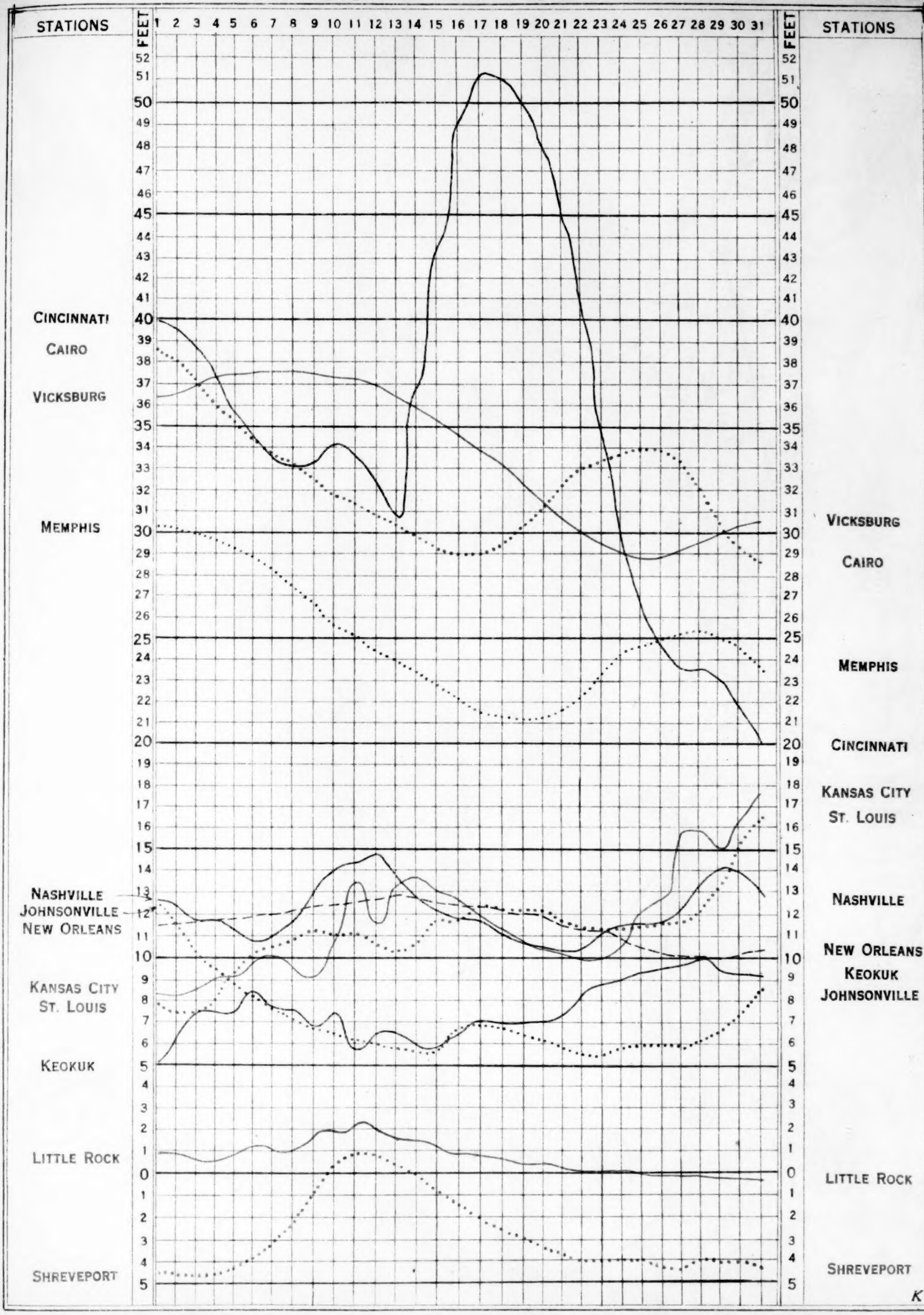

Chart II. Tracks of Centers of High Areas, March, 1918.
(Plotted by Charles A. Donnel.)

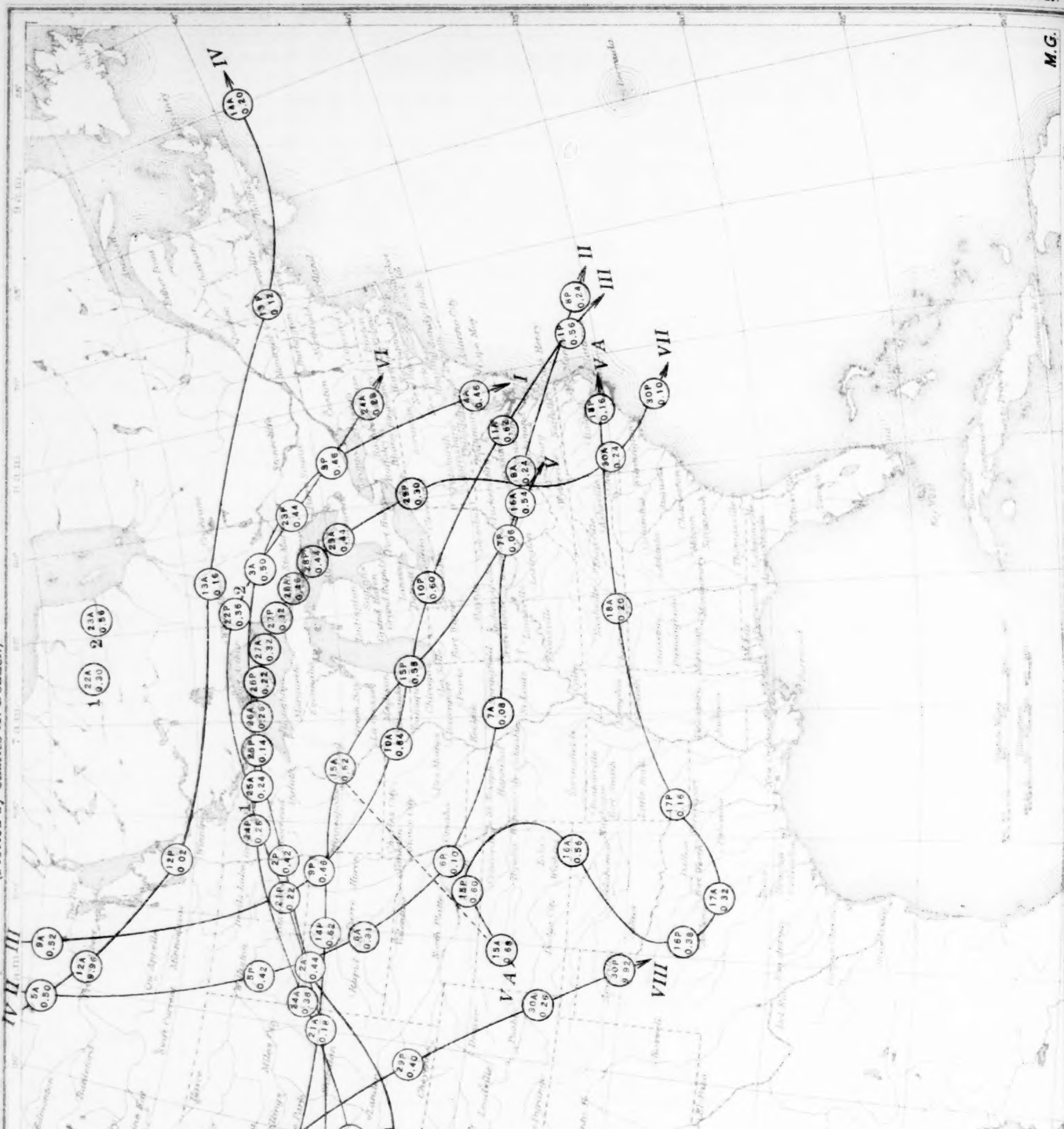

Chart III. Tracks of Centers of Low Areas, March, 1918.
(Plotted by Charles A. Donnel.)

Chart III. Tracks of Centers of Low Areas, March, 1918.
(Plotted by Charles A. Donnel.)

Chart IV. Departure (°F.) of the Mean Temperature from the Normal, March, 1918.

Chart V. Total Precipitation, March, 1918.

Chart VI. Percentage of Clear Sky between Sunrise and Sunset, March, 1918.

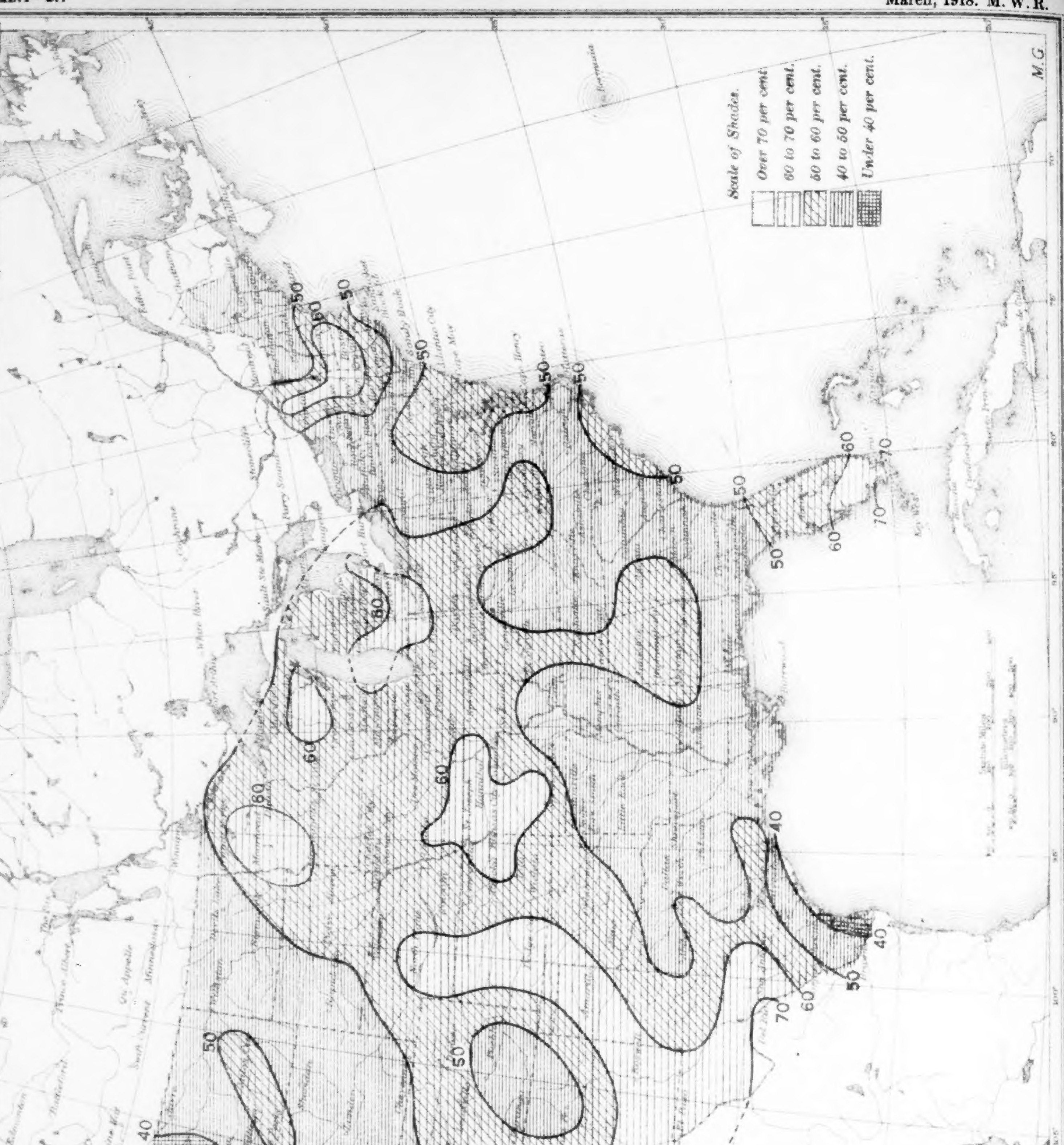

Chart VII. Isobars and Isotherms at Sealevel; Prevailing Winds, March, 1918.

Chart VII. Isobars and Isotherms at Sealevel; Prevailing Winds, March, 1918.

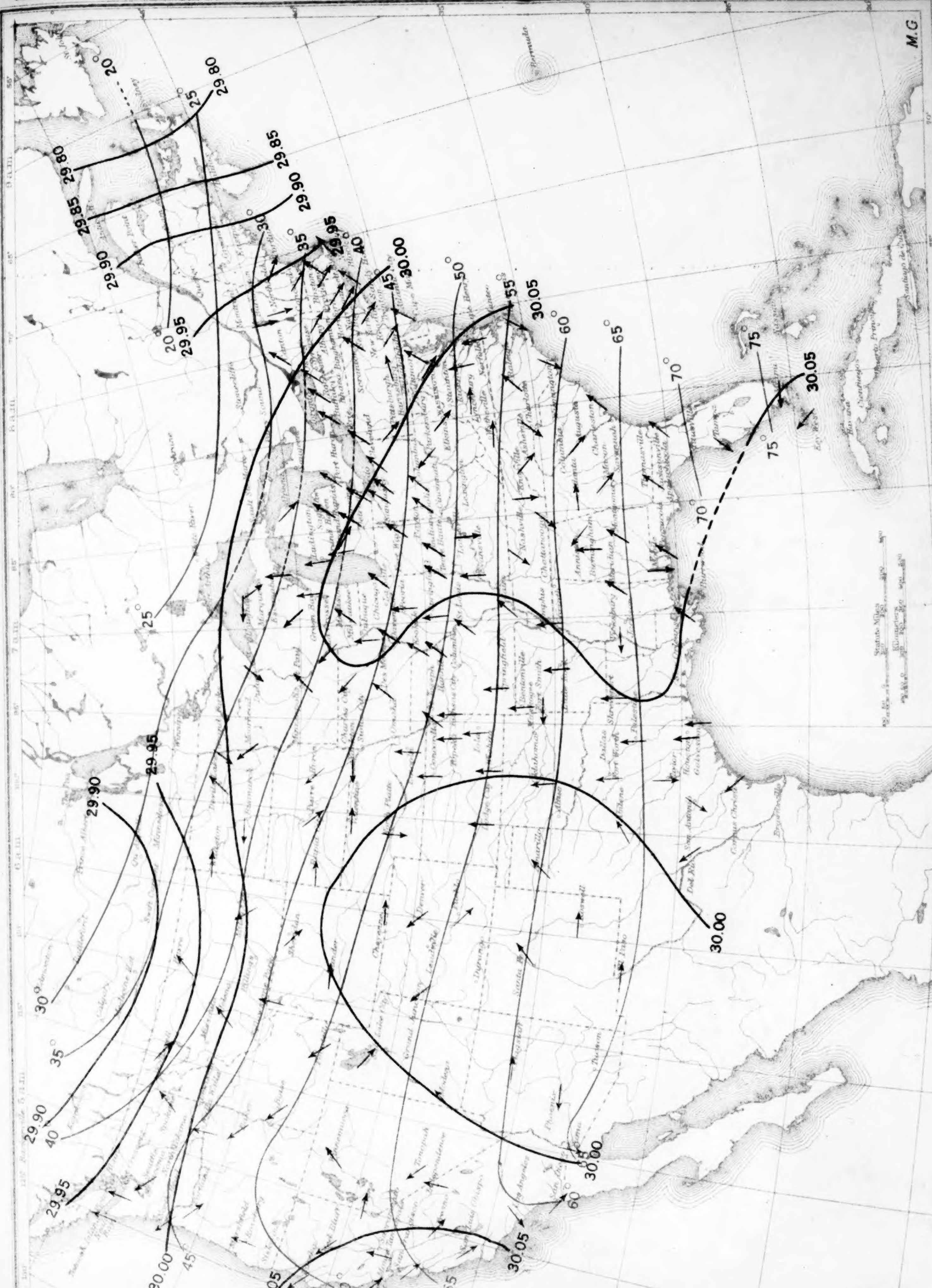

Chart VIII. Total Snowfall, Inches, March, 1918.

Chart IX. Means of Meteorological Data for North Atlantic Ocean, March, 1917.

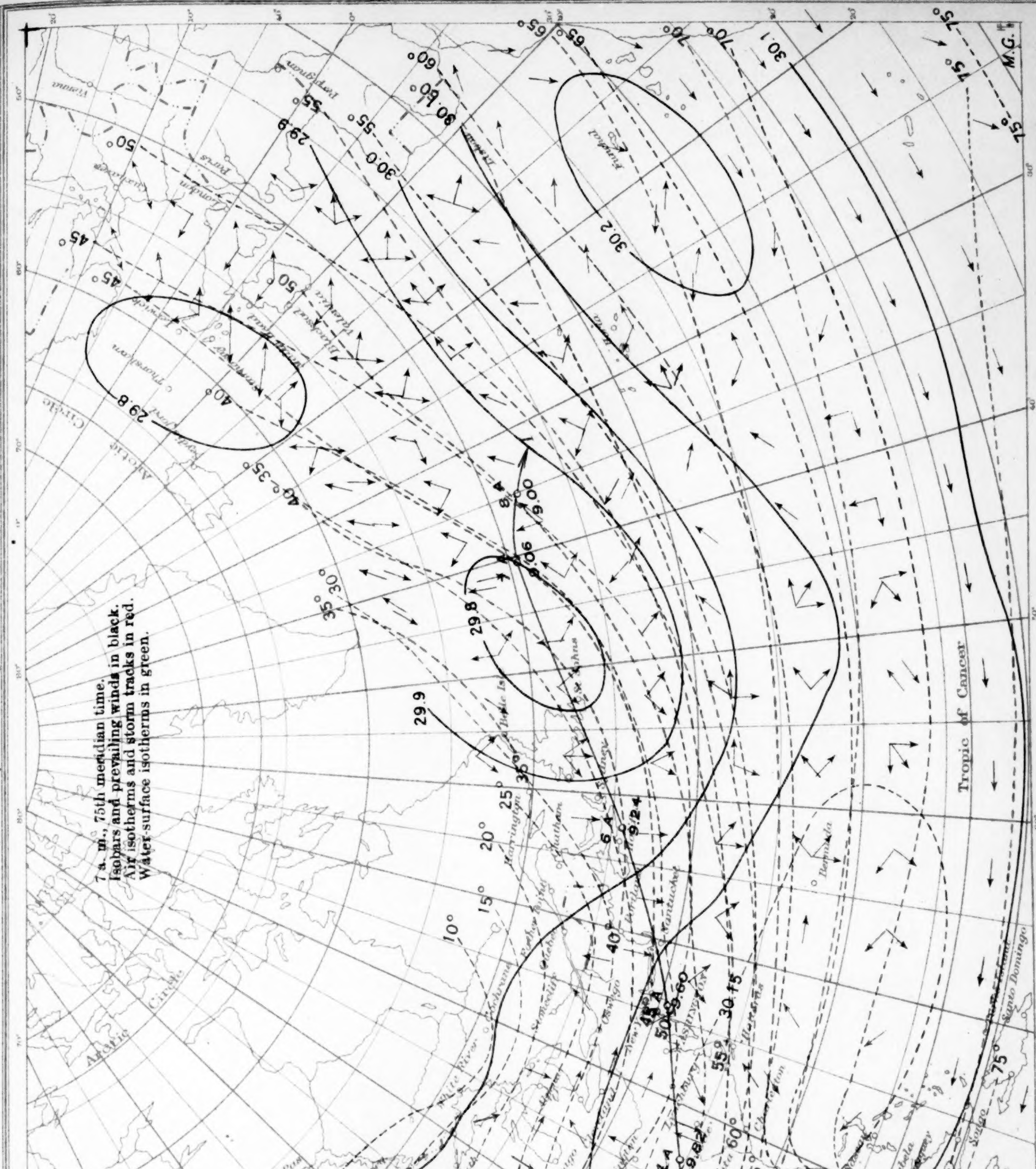

Chart IX. Means of Meteorological Data for North Atlantic Ocean, March, 1917.
(Plotted by F. A. Young.)